551.21
W84

Wonders of Creation

Volcanoes and their Phenomena

50 + c/le
Stud
2 cal pl.

THE UNIVERSITY
OF ILLINOIS
LIBRARY

From the collection of
Julius Doerner, Chicago
Purchased, 1918.

551.21
W84.

Return this book on or before the
Latest Date stamped below.

University of Illinois Library

APR 16 1959

DEC -8 1961

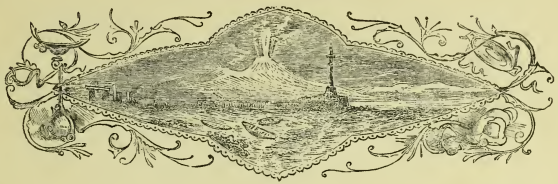
Digitized by the Internet Archive
in 2015

https://archive.org/details/wondersofcreatio00unse

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

MOUNT VESUVIUS

(The Eruption of December 1861)



WONDERS OF CREATION:

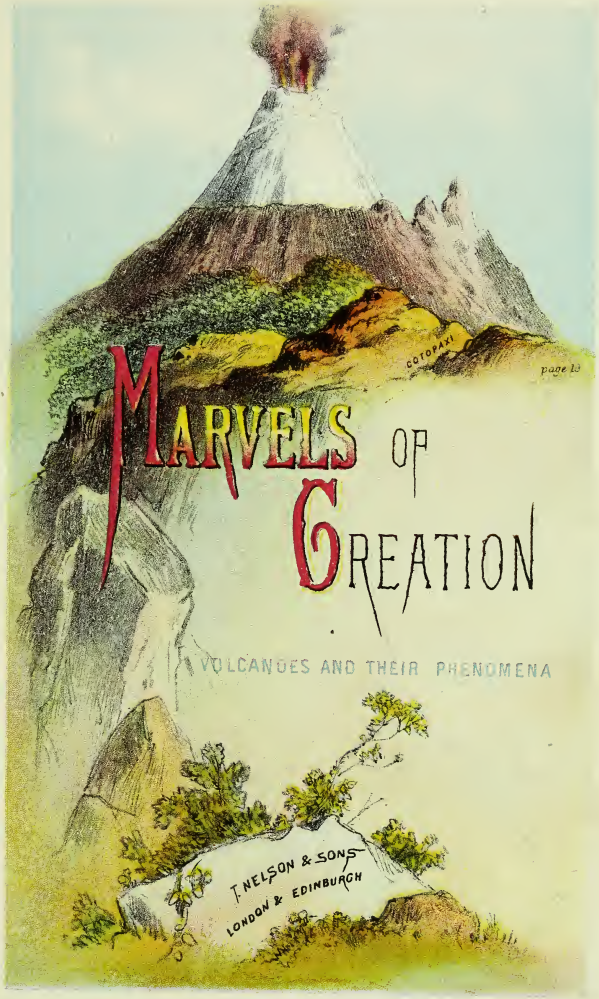
A DESCRIPTIVE ACCOUNT OF

VOLCANOES AND THEIR PHENOMENA.

"The mountains quake at Him, and the hills melt, and the earth is burned at His presence."—NAHUM i. 5

LONDON:
T. NELSON AND SONS PATERNOSTER ROW;
EDINBURGH, AND NEW YORK.

1877.


COTOPAXI
page 13
MARVELS OF CREATION
VOLCANOES AND THEIR PHENOMENA
T. NELSON & SONS
LONDON & EDINBURGH

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

551.21
W84

5 Oct. 29 Achelpohl

Preface.

BEING intended for the Young, this work treats of Volcanoes only in a popular way. Scientific details and philosophical speculations are accordingly avoided. Nevertheless, a perusal of the following pages may so stimulate the curiosity of youthful minds, that some, on attaining to riper years and more mature understanding, may be inspired with a longing to inquire more deeply into this interesting subject. They may be stimulated to investigate, in a philosophical spirit, all the marvellous facts and phenomena connected with volcanic agency, and to speculate on their causes and modes of operation. Some also, on reaching their manhood, may be induced to ascend one or more of the nearer active volcanoes, and examine their phenomena for themselves. The facilities of travel are now so great, that a visit to Vesuvius or Etna is no longer beyond the limits of a holiday trip. Even the more remote Hecla with the playful

692390

Geysers may be reached within a reasonable time. Perhaps a very few, who are now scientific travellers in embryo, may call to remembrance what they may have read in these pages, when, many years hence, they may be climbing the cone of Cotopaxi, or peering into the crater of Kilauea.

Apart from these considerations, a perusal of this work may enable the young mind to form a more lively idea of the tremendous energy of the forces which are imprisoned in the bowels of the earth. Such a vivid conception will naturally lead to a higher appreciation of the wisdom and power of Him who guides the operation of those forces by his laws, and has set bounds to their activity which they cannot overpass.

Contents.

CHAPTER I.

Page

Volcanoes in general—Origin of the Name—General Aspect—Crater—Cone—Subordinate Cones and Craters—Peak of Teneriffe—Lava-Streams—Cascades and Jets of Lava—Variations in its Consistency—Pumice—Different Sorts of Lava—Obsidian—Olivine—Sulphur—Dust, Ashes, &c.—Volcanic Silk—Volcanic Islands—Volcanic Fishes—Hot Water, Mud, Vapours, &c.—Volcanic Storm—Explosions—Number of Volcanoes—King of the Volcanoes—Artificial Volcano 9

CHAPTER II.

Volcanoes of Iceland—Mount Hecla—Earliest Eruption—Great Eruption in 1845—Skaptàr Yökul—Terrible Eruption in 1783—Rise and Disappearance of Nyoë—Katlugaia—The Geysers—A very hot Bath—Californian Geysers—Iceland-spar—Jan Mayen 21

CHAPTER III.

Mount Vesuvius—Origin of Name—Former Condition—Eruption of A.D. 79—Death of Pliny—Destruction of Pompeii and Herculaneum—Appearance of the Mountain before and

Page

after Eruption—Formation of Monte Nuovo—Eruption of Boiling Water—Coloured Vapours—Cascade of Lava—Discovery of Remains of Herculaneum and Pompeii—The Buildings of Pompeii—Street of Tombs—Skeletons—Sundry Shops—Ascents of Vesuvius—Crater—Temple of Serapis... 30

CHAPTER IV.

Mount Etna—Its Appearance and Height—Ancient Eruptions—Pindar's Allusion—Virgil's Description—Subordinate Cones and Craters—Caverns—Val de Bove—Formation of Monti Rossi—Eruption of 1852—Whirlwinds—Lava Torrents—Cascades of Lava—Description of Crater—Empedocles—Enceladus—Craters of 1865—Cyclopean Isles—Homer's Legend—Volcanic Origin—Other Basaltic Groups..... 44

CHAPTER V.

Lipari Islands—Stromboli—Origin of Name—Position of Crater—Description of Crater—New Volcanic Island named Julia—Phenomena preceding its Elevation—Description of Island and Crater—Its Disappearance—Rise of Islands at Santorin 55

CHAPTER VI.

Peak of Teneriffe—Its Crater—Eruption of Chahorra—Palma—Great Caldera—Lancerote—Great Eruption—Sudden Death—Fuego, Cape de Verde Islands—Cotopaxi—Its Appearance—Great Eruptive Force—Tunguragua—Great Eruption of Mud and Water—Fish thrown out—Quito—Its Overthrow—Pichinca—Humboldt's Ascent—Narrow Escape—Antisana—Sangay—Rancagua—Chillan—Masaya 65

CHAPTER VII.

Jorullo—Great Monument—Jorullo's Estate—Interruption to his Quiet—His Estate Swells—Swallows Two Rivers—

Page

Throws up Ovens—Becomes a Burning Mountain—Popocatepetl—Spanish Ascents—Orizaba—Müller's Ascent—Morne-Garou—Pelée—La Soufrière..... 72

CHAPTER VIII.

Hawaii, Sandwich Islands—Crater of Kilauea—Its awful Aspect—Fiery Lake and Islands—Jets of Lava—Depth of Crater and Surface of Lake—Bank of Sulphur—Curious Rainbow—Mouna-Kaah and Mouna-Loa—Eruption of the Latter in 1840—Recent Eruption—Great Jet and Torrent of Lava—Burning of the Forests—Great Whirlwinds—Underground Explosions—Other Volcanoes in the Pacific..... 83

CHAPTER IX.

Atolls, or Coral Islands—Their strange Appearance—Their Connexion with Volcanoes—Their Mode of Formation—Antarctic Volcanoes—Diatomaceous Deposits..... 89

CHAPTER X.

Volcanoes of Java—Papandayang—Mountain Ingulfed—Great Destruction of Life and Property—Galoen-gong—Destructive Eruption—Mount Merapia—Great Eruption, with Hurricane—Another, very destructive—Mud Volcano—Crater of Tankuban-Prahu—Island of Sumbáwa—Volcano of Tomboro—Terrific Eruption—Timor—A Volcano quenches itself—Cleaving of Mount Machian—Sangir—Destructive Eruption—Bourbon..... 96

CHAPTER XI.

Mud and Air Volcanoes—Luss—Macaluba—Taman—Korabetoff New Island in the Sea of Azof—Jokmali—Fires of Baku—Mud Volcano in Flank of Etna—Air Volcanoes of Turbaco, Cartagena, and Galera-Zamba..... 103

CHAPTER XII.

Page
New Zealand—Boiling Fountains and Lakes..... 108

CHAPTER XIII.

Underground Sounds—Quito—Rio Apure—Guanaxuato—Melida —Nakous..... 111

CHAPTER XIV.

Extinct Volcanoes—Auvergne—Vienne—Agde—Eyfel—Italy— Lacus Cimini — Grotto del Cane — Guevo Upas—Talaga Rodas—The Dead Sea..... 114

WONDERS OF CREATION:

VOLCANOES AND THEIR PHENOMENA.

CHAPTER I.

Volcanoes in general—Origin of the Name—General Aspect—Crater—Cone—Subordinate Cones and Craters—Peak of Teneriffe—Lava-Streams—Cascades and Jets of Lava—Variations in its Consistency—Pumice—Different Sorts of Lava—Obsidian—Olivine—Sulphur—Dust, Ashes, &c.—Volcanic Silk—Volcanic Islands—Volcanic Fishes—Hot Water, Mud, Vapours, &c.—Volcanic Storms—Explosions—Number of Volcanoes—King of the Volcanoes—Artificial Volcano.

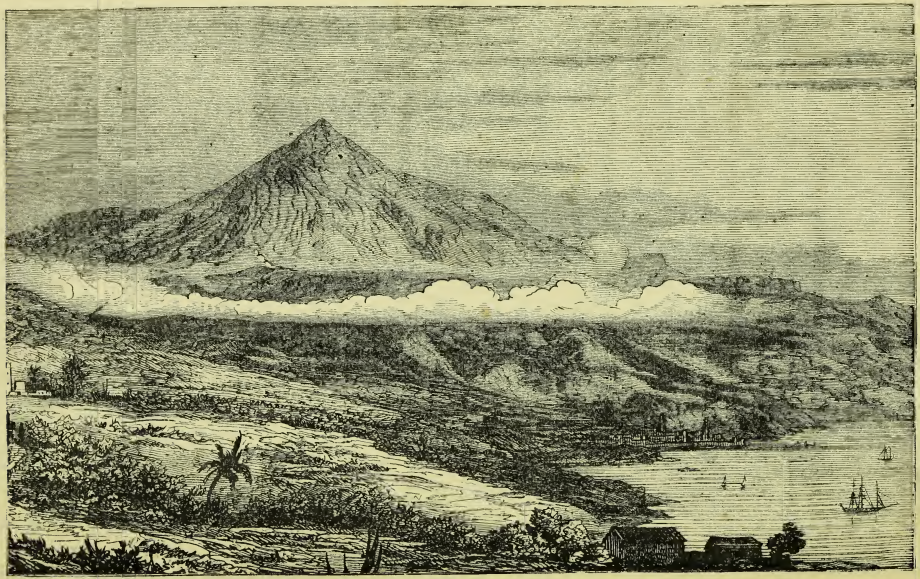
AMONG the many wonderful works of God, none exhibits so much of awful grandeur as an active volcano. This name for a burning mountain was first applied to that which exists in the island anciently called Hiera, one of the Lipari group. It is derived from the name of the heathen god Vulcan, which was originally spelt with an initial B, as appears from an ancient altar on which were inscribed the words BOLCANO SAC. ARA. This spelling indicates the true derivation of the name, which is simply a corruption of Tubal-cain,

who was "an instructer of every artificer in brass and iron" (Gen. iv. 22). The ancient heathen, having deified this personage, imagined, on first seeing a burning mountain, that Tubal-cain, or Vulcan, must have established his forge in the heart of it, and so, not unnaturally, named it Volcano—an appellation which the Island of Hiera retains to the present day.

The Cyclops—the supposed descendants of Vulcan, who were fabled to have been of gigantic stature, and to have had each only one eye in the centre of the forehead—were imagined to be the workmen who laboured in these underground forges. The noises, proceeding from the heart of the mountain, were attributed to their operations. It is to the Island of Hiera that Virgil alludes in the Æneid, lib. viii. 416. The passage is thus rendered by Dryden:—

> "Sacred to Vulcan's name, an isle there lay,
> Betwixt Sicilia's coasts and Lipare,
> Raised high on smoking rocks, and deep below,
> In hollow caves the fires of Etna glow.
> The Cyclops here their heavy hammers deal;
> Loud strokes and hissings of tormented steel
> Are heard around; the boiling waters roar,
> And smoky flames through fuming tunnels soar."

A volcano generally presents itself to the imagination as a mountain sending forth from its summit great clouds of smoke with vast sheets of flame, and it is not unfrequently so described. The truth is, however, that a real volcano seldom emits either true smoke or true flame. What is mistaken for smoke consists merely of vast volumes of fine dust, mingled with much steam and other vapours—chiefly sulphurous. What appears like flames is simply the glare from the glowing materials which are thrown



PEAK OF TENERIFFE.

up towards the top of the mountain—this glare being reflected from the clouds of dust and steam.

The most essential part of a volcano is the crater, a hollow basin, generally of a circular form. It is often of large dimensions, and sometimes of vast depth. Some volcanoes consist of a crater alone, with scarcely any mountain at all; but in the majority of cases the crater is situated on the top of a mountain, which in some instances towers to an enormous height. The part of the mountain which terminates in the principal crater is usually of a conical form—much like a glass-house chimney, and is therefore named the cone. It is generally composed of loose ashes and cinders, with here and there masses of stone, which have been tossed into the air by the volcanic forces. In some mountains the cone rises out of a hollow at a considerable height from the base. A hollow of this kind is generally regarded as having been a former crater, which had become extinct before the existing cone was raised. There are sometimes formed lower down the mountain subordinate craters, smaller than that which occupies the summit of the cone. Within the crater itself there are frequently numerous little cones, from which vapours are continually issuing, with occasional volleys of ashes and stones.

One of the largest and most perfect of the volcanic cones in the world is that of the Peak of Teneriffe, of which you have here a representation. It conveys a good idea of the general form of the cone, and has long been a conspicuous and useful landmark to mariners. It is upwards of twelve thousand feet in

height, and is said to be visible in very clear weather at a distance of a hundred miles.

The most interesting products of an active volcano are the streams of lava which it pours forth—sometimes from the principal crater on the summit—sometimes from the smaller craters lower down. This lava consists of melted stone. When it issues from the mountain its heat is intense and it glows like a furnace, so that, during the night especially, these fiery rivers present a grand yet awful spectacle. The streams spread themselves till they sometimes attain a breadth of several miles, with a depth of several hundred feet, and they flow onward till their length sometimes reaches fifty miles.

Lava, not being so liquid as water, does not flow so rapidly: nevertheless, when it is careering down the sides of a mountain, or where the slope of the ground is considerable, it advances with great speed. Even when at its hottest, it is somewhat viscid, like treacle, and this viscidness increases as it cools. Hence on a level plain, and at some distance from its source, the lava-stream advances at a leisurely pace. In such circumstances the cooling proceeds so quickly that a crust of considerable thickness is soon formed on the top of the current, and persons who are bold enough may cross the stream by means of this natural bridge. Even where the current continues flowing rapidly, this crust may be formed on its surface; and a man, whose curiosity exceeds his prudence, may stand on the top of it, bore a hole through the crust, and see the lava flowing underneath his feet!

Nothing can resist the progress of the lava-flood;

trees, houses, everything yields to its massive assault. The trees take fire before its approach, and when it reaches them they emit a hissing noise almost amounting to a shriek, and then plunging into the molten flood are seen no more. Even the sea cannot withstand the lava-stream, but retires on its approach; so that promontories stretching to a considerable distance from the shore are formed in this manner, when the molten matter hardens into stone.

The eruptions of lava are sometimes attended by peculiarities which impart to them much additional grandeur. Instances have occurred in which the fiery stream has plunged over a sheer precipice of immense height, so as to produce a glowing cascade exceeding in breadth and perpendicular descent the celebrated Falls of Niagara. In other cases, the lava, instead of at once flowing down the sides of the mountain, has been first thrown up into the air as a fiery fountain several hundred feet in height. This happens when the great crater at the summit of the cone is full of liquid lava but does not overflow. Then, on the formation of an opening in the side of the cone, a good way down, the lava issuing from it is projected upwards to nearly the same height that it occupies in the interior of the crater at the top of the cone. It is hardly possible for the fancy to picture to itself anything so magnificent as such a fountain of liquid fire must be. A simple jet of water of considerable volume, thrown into the air to the height of a hundred feet, is itself a beautiful spectacle. What then must be a huge jet of glowing white lava projected to the height of several hundred

feet, and with what an awful thundering sound must it come tumbling to the ground, thence to rush as a roaring torrent down the mountain's side!

Lava, when congealed, differs in its consistency according as it is near the top or near the bottom of the stream. When near the top it is porous, owing to its rapid cooling; when near the bottom it is dense, owing to its slow cooling and the great pressure to which it is subjected. When the lighter superficial lava is brought suddenly into contact with water, as when a lava-stream enters the sea, it becomes still lighter and more porous—forming the well-known substance called pumice, so much used for polishing. It may be regarded as the solidified froth of lava, and is so light that it floats on the surface of water.

The lavas of different mountains, when cooled and hardened, differ much in their appearance and composition. Among those of Iceland is found the beautiful black volcanic glass named obsidian. It is a good deal used for ornamental purposes; for it possesses the peculiar property of presenting a different appearance according to the manner in which it is cut. When cut in one direction it is of a beautiful jetty black; when cut across that direction it is glistering gray. The lavas of Vesuvius are generally of a brown colour, and are also used in the arts. In them are found the beautiful olive-green crystals of the mineral called olivine, sometimes used by jewellers. But the most useful of all volcanic productions is native sulphur, in which Mount Etna has been very prolific. It is to this mountain chiefly, there-

fore, that we are indebted for our beautiful fire-works —our squibs, crackers, Roman candles, serpents, Catherine-wheels, and sky-rockets. Would it had produced nothing more harmful than these! But it has also supplied one of the ingredients of that villainous gunpowder, which has been the means of thrusting so many of our fellow-creatures prematurely out of the world. Etna, however, can hardly be held responsible for this sad misuse of the valuable substance which it affords; while even gunpowder itself has, on the whole, been of vast benefit to mankind. Could we only refrain from shooting each other with it, we might regard it as an almost unmixed good; for it has helped us greatly in forming our roads, railways, and tunnels, and in working our quarries and mines.

In all great eruptions the flow of the lava is preceded by the ejection of vast quantities of volcanic dust, ashes, dross, slag, and loose stones. These are tossed into the air with tremendous violence, consequently, to a great height. The stones thus ejected are sometimes of immense size. A rock, whose weight is estimated at two hundred tons, was thrown from the summit of Cotopaxi to the distance of more than ten miles. Large stones have been tossed up by Vesuvius to the estimated height of three thousand six hundred feet. The dust of the volcano of St. Vincent was carried more than two hundred miles to the eastward in the teeth of the trade wind; consequently it must have been thrown to an enormous height, in order to its falling at so vast a distance from its source.

Besides the usual volcanic dust and ashes, there is sometimes thrown from the crater of a volcano a substance resembling spun-glass or asbestos. It possesses the flexibility and lustre of silk. The volcano of Salazes, in the Island of Bourbon, is remarkable for this substance, and it has there been seen to form a cloud covering the entire surface of the mountain. But it has also been found in other places. How curious it would be to have this volcanic silk spun into threads, and knitted into stockings or woven into a garment! Who can tell what may happen in these days of adventure and invention? Who knows but what some young reader, whose eye is now resting on this page, may yet live to present his lady-love with a pair of knitted gloves composed of the volcanic silk of Salazes?

Great as the contrast is between this filmy material and the ponderous blocks tossed into the air by Cotopaxi and Etna, it is not greater than that between the latter and other masses which have from time to time been upheaved by volcanic forces. Instances have occurred of whole islands having been raised from the bed of the ocean, or whole mountains upreared on the surface of the land, far away from the sea, and that too in the short space of a few hours. But of such we shall have occasion to speak more at large in the sequel.

Of all the extraordinary productions that have ever been thrown up by volcanoes, the strangest of all are fishes. How droll to dine upon fish cooked in a volcano! A queer fish it must be that likes to dwell in the bowels of a mountain—more especially of one

whose entrails are mostly of liquid fire. But of this also more fully anon.

In addition to the solid materials thrown out by volcanoes, there are sometimes poured forth torrents of boiling water and liquid mud. More frequently, however, the water issues in the form of vast columns of steam and sulphurous vapour. These ascend to great heights in the air, and becoming gradually chilled, they form immense masses of dark heavy clouds, similar to those we observe before a thunder-storm. Nor is this resemblance apparent only. For the clouds that overhang an active volcano during an eruption of its vapours are, in reality, thunder-clouds highly charged with electricity. They accordingly produce what Baron Humboldt calls the volcanic storm. It includes all the most terrible of atmospheric phenomena—lightnings of extraordinary vividness; thunders that peal and reverberate as if they would rend the echoes asunder; torrents of rain that pour down upon the mountain and its neighbourhood, hissing like thousands of serpents when they fall on the glowing lava-torrent; and whirlwinds that sweep the volcanic ashes round and round in vast eddies, and before whose violence no man of mortal mould is able for a moment to stand.

Beyond and above this din of contending elements are heard the hoarse bellowings of the mountain itself, which, meanwhile, trembles to its very core. The detonations from the volcano far exceed in loudness any other earthly noise. Compared with these, the pealing of the loudest thunder is but as the report of a musket contrasted with the simultaneous dis-

charge of a thousand pieces of heavy ordnance. The explosions of Tomboro, and the vibrations accompanying them, have been heard and felt at almost incredible distances. Judge, then, of the immensity of the forces which are thus brought into play, and the overwhelming grandeur of the scene which such an eruption, with all its accompaniments of storm and tempest, must present to the bewildered eye and ear. Even to read of it sends a thrill through the nerves: what, then, must it be to listen and behold?

So far do we dwell from the nearest volcanoes, and so little are we familiar with the names except of a few, that not many persons are aware of the large number of burning mountains on the face of our globe. The total number, however, of those which are known to have been active within historic times is fully two hundred. Of these, the most familiar to us for its classic fame and its restless activity is Mount Vesuvius, which stands alone in its grandeur on the continent of Europe. The most violent in its activity is Tomboro, in the island of Sumbáwa. The highest is Cotopaxi, in the range of the Andes, which rises far into the region of perpetual snow. Its height is 16,800 feet above the level of the sea. Strange it seems, that volcanic fires should glow at such a height in the midst of snow and ice. But in this particular Cotopaxi does not stand alone. The Peak of Teneriffe, Mount Etna, and several others, also rise above the snow-line; while the burning mountains of Iceland, Greenland, and Kamtschatka, with those which rear their heads in the frozen regions near the South Pole, are for the most part enveloped in ice and snow from head to foot.

Before proceeding to describe to you some of the more interesting of the individual volcanoes and volcanic groups, it may be well to let you into a secret worth knowing. You would doubtless like to have a volcano all to yourself. Here is the receipt: Buy several pounds of clean iron filings, and a somewhat larger quantity of the flowers of sulphur. Mix the two together and knead them well with water into a stiffish paste. Then wrap this pudding in a cloth, and put another cloth about it, which has been smeared with common or coal-tar. Dig a hole in some quiet corner of your garden, pop your dumpling into it, and cover it well up with earth, treading it down firmly with your feet. Not many hours will elapse before you will see the ground swell like a mole-hill; an eruption will ensue, and you will be the happy possessor of a Stromboli of your own!

CHAPTER II.

Volcanoes of Iceland — Mount Hecla — Earliest Eruption — Great Eruption in 1845—Skaptâr Yökul—Terrible Eruption in 1783—Rise and Disappearance of Nyoë—Katlugaia—The Geysers—A very hot Bath—Californian Geysers—Iceland-spar—Jan Mayen.

WE shall begin with the volcanoes of Iceland, of which the most interesting and active is Mount Hecla. The annexed woodcut will give you an idea of its appearance. You will observe the column of volcanic vapour ascending from the snow-clad summit of the cone, and how dreary and desolate is the aspect of the country at its base.

The earliest recorded eruption of Mount Hecla took place in the ninth century of the Christian era; but probably there had been many before that date. Since then there have been between twenty and thirty considerable eruptions of this mountain, and it has sometimes remained in a state of activity for upwards of six years with little intermission. It took a long rest, however, of more than sixty years' duration, prior to the year 1845, when it again burst forth. After a violent storm on the night of the 2nd of September in that year, the surface of the ground in the Orkney Islands was found strown with volcanic dust. There was thus conveyed to the inhabitants of Great Britain an intimation that Hecla had been again at

work. Accordingly, tidings soon after arrived of a great eruption of the mountain. On the night of the 1st of September, the dwellers in its neighbourhood were terrified by a fearful underground groaning, which continued till mid-day on the 2nd. Then, with a tremendous crash, there were formed in the sides of the cone two large openings, whence there gushed torrents of lava, which flowed down two gorges on the flanks of the mountain. The whole summit was enveloped in clouds of vapour and volcanic dust. The neighbouring rivers became so hot as to kill the fish, and the sheep fled in terror from the adjoining heaths, some being burnt before they could escape.

On the night of the 15th of September, two new openings were formed—one on the eastern, and the other on the southern slope—from both of which lava was discharged for twenty-two hours. It flowed to a distance of upwards of twenty miles, killing many cattle and destroying a large tract of pasturage. Twelve miles from the crater, the lava-stream was between forty and fifty feet deep and nearly a mile in width. On the 12th of October a fresh torrent of lava burst forth, and heaped up another similar mass. The mountain continued in a state of activity up to April 1846; then it rested for a while, and began again in the following month of October. Since then, however, it has enjoyed repose.

The effects of these eruptions were disastrous. The whole island was strown with volcanic ashes, which, where they did not smother the grass outright, gave it a poisonous taint. The cattle that ate

MOUNT HECLA.

of it were attacked by a murrain, of which great numbers died. The ice and snow, which had gathered about the mountain for a long period of time, were wholly melted by the heat. Masses of pumice weighing nearly half a ton were thrown to a distance of between four and five miles.

Mount Hecla is not the only volcano in Iceland. There are several others; and from one of them, named Skaptàr Yökul, there was, in the year 1783, an eruption still more violent than that from Hecla above described. It began on the 8th of June, and raged with little abatement till the end of August, whence onward it continued, but with less violence, till the following year. The lava, in this case, poured from numerous openings; but these rivulets ultimately united themselves into two large currents, which flowed onwards to the sea. In their progress, these burning torrents filled up the beds of two considerable rivers. The greater of the two streams, after it had ceased to flow and had become a solid mass of rock, measured fifty miles in length, and between twelve and fifteen miles in breadth. Its average depth on the plains was about a hundred feet; but in the bed of the river, which it had filled, it was not less than six hundred feet. The snow and ice, which had previously covered the mountain, were not only melted, but the water that flowed from them was raised to the boiling point, and poured down with destructive effect on the plains. The dust and ashes thrown into the air darkened the sun; and they were then strown over the surface of the island, destroying all the pastures, so that many

thousands of cattle, horses, and sheep perished. But worse than that, upwards of nine thousand persons lost their lives by this dreadful catastrophe.

About a month before this great eruption of Skaptàr Yökul, a volcanic island was thrown up from the sea, at a distance of about seventy miles from Iceland. So great was the quantity of ashes and dross ejected from its crater, that it overspread the sea to a distance of a hundred and fifty miles, forming a crust which obstructed the progress of ships. Portions of this crust floated as far as the Shetland and Orkney islands. The King of Denmark named this fiery apparition "Nyoë," or "New Island," and doubtless prided himself not a little on this addition to his limited dominions. But, alas, for human ambition! About a year after the date of its first appearance, Nyoë sank into the depths out of which it arose, and its position is now marked only by a moderate shoal.

It is not by their ejected lavas alone that the volcanoes of Iceland produce their destructive effects. Disastrous consequences have frequently resulted from the sudden melting of their snows and glaciers, on which the volcanic fires operate far more rapidly than does the heat of the sun. It is chiefly by the vast quantities of earth, sand, stones, and broken fragments of rock, which they hurry along with them in their wild career, that the waters, so suddenly freed, produce the greatest amount of damage. During an eruption of Katlugaia, one of the southern Icelandic volcanoes, in 1756, the mass of material thus carried down by the melted snows and glaciers

was so great, that, advancing several leagues into the sea, it formed three parallel promontories, which rose above the sea-level, where there had formerly been a depth of forty fathoms of water. Vast ravines were, at the same time, scooped out of the sides of the mountain by the erosion of the waters. Another eruption of this volcano in 1860 produced similar results.

Still more interesting than the volcanic mountains of Iceland are its Geysers, or intermittent springs of boiling water. The chief of these is the Great Geyser. A jet rises to a vast height, and is accompanied by much steam. Indeed, it is quite at the boiling-point.

The little mound, from the top of which the jet appears to rise, is composed of a substance named siliceous sinter, and is a deposit from the water of the fountain. At the top of this mound, which is between six and seven feet in height, there is an oval basin, measuring about fifty-six feet in one direction, and about forty-six in the other; its average depth is about three feet. In the centre of this basin is a round hole, about ten feet in diameter, out of which the water springs. This hole is the mouth of a circular well, between seventy and eighty feet in depth. It is down this well that the jet retires on its disappearance; and it drags along with it all the water out of the basin, leaving both basin and well quite empty, without even a puff of steam coming out of the hole. In this state of emptiness the basin and well remain for several hours. Suddenly the water begins to rise in the well, overflowing till it fills the

basin. Loud explosions are heard from below, and the ground trembles. Then, with amazing violence, up springs a vast column of boiling water, surmounted by clouds of steam, which obscure the air. This first jet is followed by several others in rapid succession, to the number of sixteen or eighteen; the last jet being usually the greatest of all, and attaining a height of nearly a hundred feet. In some instances it has risen to a height of a hundred and fifty feet; and one particular jet was measured which rose to the amazing height of two hundred and twelve feet.

The action of the fountain seldom continues more than about five minutes at a time, and then a repose of several hours ensues. If left to itself, the periods of the fountain's activity, though not quite regular, generally recur at intervals of six or seven hours. But they may be hastened by throwing big stones down the well. This not only hurries the eruption of the jet, but increases its energy, and the stones are thrown out with great force by the column of boiling water; the loudness of the explosions being also considerably augmented.

There are several other geysers in the island besides this big one. Their jets are smaller, but to compensate this deficiency, they are more frequent in their ascent; so that travellers who are too impatient to await the eruptions of the Great Geyser, content themselves with visiting the little ones.

Would it not be very convenient to live near a geyser? We might have our victuals cooked by it, and have pipes led from it all round our house, to keep us comfortable in winter; and we might have

nice hot baths in our dressing-rooms, and even a little steam-engine to roast our meat and grind our coffee. But perhaps you may think it might not be altogether pleasant to be kept so continually in hot water.

Were any of the water from the geyser to fall on your hands, you would doubtless feel it rather sore; still more so, were you to be so rash as to thrust your hand fairly into the jet of boiling water, as it ascends into the air. Nevertheless, strange as it may seem, it would be possible for you, without feeling any pain or sustaining any injury, to thrust your hand right into the glowing lava as it flows from the crater of Hecla. The only precaution needful to be observed, is first to plunge the hand into cold water, and then dry it gently with a soft towel, but so as to leave it still a little moist. This discovery was made by a French philosopher, M. Boutigny, and has been practically proved both by him and M. Houdin, the celebrated conjuror, by thrusting their hands into molten iron, as it flowed from the furnace. The latter describes the sensation as like what one might imagine to be felt on putting the hand into liquid velvet.* The reason why this experiment proves so harmless is that between the skin and the glowing substance there is formed a film of vapour, which acts as a complete protection. It is this elastic cushion of vapour which imparts that feeling of softness described by M. Houdin; for it is with it alone that the hand comes into contact.

Geysers have been recently discovered in Califor-

* Houdin's Autobiography, ii. 270.

nia; but the jets do not rise higher than twenty or thirty feet. They are, however, very numerous, there being upwards of a hundred openings within a space of half a mile square. The vapour from the whole group rises to upwards of a hundred and fifty feet into the air. The boiling water issues from conical mounds, with great noise. The whole ground around them is a mere crust, and when it is penetrated the boiling water is seen underneath. The Californian geysers, however, are impregnated, not with silica, like those of Iceland, but with sulphur, of which they form large deposits. The sulphurous vapours from the water corrode the rocks near the fountains; nevertheless trees grow, without injury to their health, at a distance from them of not more than fifty feet.

Besides obsidian, already mentioned as a product of its volcanoes, Iceland is famed for another mineral of great scientific value. It is that fine variety of carbonate of lime named Iceland-spar. Transparent and colourless, like glass, this mineral possesses the property of double refraction—any small object viewed through it in a particular direction appearing double. It is much used for optical purposes—especially for obtaining polarized light.

There is another volcano lying far to the northward of Iceland. It is in the island of Jan Mayen, off the coast of Greenland, and has on its summit a vast crater, 2000 feet in diameter, and 500 in depth.

CHAPTER III.

Mount Vesuvius—Origin of Name—Former Condition—Eruption of A.D. 79—Death of Pliny—Destruction of Pompeii and Herculaneum—Appearance of the Mountain before and after Eruption—Formation of Monte Nuovo—Eruption of Boiling Water—Coloured Vapours—Cascade of Lava—Discovery of Remains of Herculaneum and Pompeii—The Buildings of Pompeii—Street of Tombs—Skeletons—Sundry Shops—Ascents of Vesuvius—Crater—Temple of Serapis.

MOUNT VESUVIUS is the only active volcano on the continent of Europe, and it is highly interesting both from its historical associations and the frequency of its eruptions. It is situated on the coast of the Bay of Naples, about six miles to the eastward of the city and at a short distance from the shore. It forms a conspicuous feature in the beautiful landscape presented by that bay, when viewed from the sea, with the city in the foreground.

Mount Vesuvius was in ancient times held sacred to the deified hero Hercules, and the town of Herculaneum, built at its base, was named after him. So also, it is said, was the mountain itself, though in a more round-about way. Hercules, as you will doubtless learn, was feigned to have been the son of the heathen god Zeus and Alcmena, a Theban lady. Now one of the appellations of Zeus was Ὕης, which

was applied to him as being the god of rains and dews—the wet divinity. Thus Hercules was Ὑησουνιός, the son of Ves. How this name should have become corrupted into "Vesuvius," you can be at no loss to perceive.

Vesuvius was not always a volcano. It was for many ages a very peaceable and well-behaved mountain. Ancient writers describe it as having been covered with gardens and vineyards, except at the top which was craggy. Within a large circle of nearly perpendicular cliffs, was a flat space sufficient for the encampment of an army. This was doubtless an ancient crater; but nobody in those times knew anything of its history. So little was the volcanic nature of the mountain suspected, that the Roman towns of Stabiæ, Pompeii, and Herculaneum had been erected at its base, and their inhabitants dwelt in fancied security.

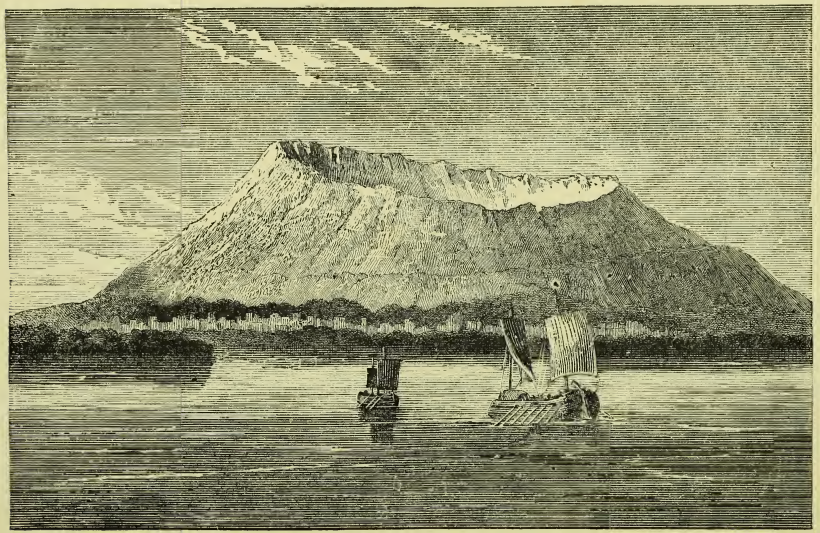
In the year A.D. 63, however, the dwellers in the cities got a great fright; for the mountain shook violently, and a good many houses were thrown down. But soon all became quiet again, and the people set about rebuilding the houses that had fallen. They continued to live in apparent safety for some time longer. They danced, they sung, they feasted, they married, and were altogether as merry a set of citizens as any in southern Italy. But the 24th of August A.D. 79 at length arrived. Then, woe to Stabiæ! woe to Pompeii! woe to Herculaneum!

Pliny the elder was that day in command of the Roman fleet at Misenum, which was not far off. His family were with him, and, among others, his

nephew, Pliny the younger, who has left an interesting account of what happened on the occasion. He observed an extraordinary dense cloud ascending in the direction of Vesuvius, of which he says:—"I cannot give you a more exact description of its figure, than by resembling it to that of a pine tree; for it shot up to a great height in the form of a tall trunk, which spread out at the top into a sort of branches. It appeared sometimes bright, and sometimes dark and spotted, as it was either more or less impregnated with earth and cinders."

On seeing this remarkable appearance, the elder Pliny, who was a great naturalist and a man of inquiring mind, resolved to go ashore and inspect more narrowly what was going on. But a rash resolve it proved. Steering towards Retina (now Resina), a port at the foot of the mountain, he was met, on his approach, by thick showers of hot cinders, which grew thicker and hotter as he advanced—falling on the ships along with lumps of pumice and pieces of rock, black but burning hot. Vast fragments came rolling down the mountain and gathered in heaps upon the shore. Then the sea began suddenly to retreat, so that landing at this point became impracticable. He therefore steered for Stabiæ, where he landed, and took up his abode with Pomponianus —an intimate friend.

Meanwhile, flames appeared to issue from several parts of the mountain with great violence—the darkness of the night heightening their glare. Pliny nevertheless went to sleep. Soon, however, the court leading to his chamber became almost filled



VESUVIUS BEFORE THE ERUPTION OF A.D. 79.

with stones and ashes; so his servants awoke him, and he joined Pomponianus and his household. The house now began to rock violently to and fro; while outside, stones and cinders were falling in showers. They, notwithstanding, thought it safer to make their way out from the tottering mansion; so, tying pillows upon their heads with napkins, they sallied forth. Although it was now day, the darkness was deeper than that of the blackest night. By the aid of torches and lanterns, however, they groped their way towards the beach, with a view to escape by sea; but they found the waves too high and tumultuous. Here Pliny, having drunk some cold water, lay down upon a sailcloth which was spread for him; when almost immediately flames, preceded by a strong smell of sulphur, issuing from the ground, scattered the company and forced him to rise. With the help of two of his servants he succeeded in raising himself; but, choked by some noxious vapour, he instantly fell down dead.

Nor was he alone in his death; for although many of the inhabitants of the devoted cities were able to effect their escape; yet, so suddenly did the overwhelming shower of ashes, cinders, and stones fall upon them, that not a few of them perished in their dwellings or their streets. As for the cities themselves, they were utterly buried completely out of sight, and, like other things that are long out of sight, they soon became also buried out of mind. For many centuries they remained entirely forgotten.

You will doubtless like to know how Vesuvius looked, after doing so much mischief. Here is a

VESUVIUS AFTER THE ERUPTION OF A.D. 79.

picture showing what like it was immediately before the eruption; and one showing its appearance soon after the event. On comparing the two, you will observe the mountain had undergone a great change. It was no longer flat on the top, but had formed for itself a large cone, from the summit of which dense vapours ascended. This cone was composed entirely of the ashes, cinders, and loose stones, thrown up during the eruption. It had become separated by a deep ravine from the remainder of the former summit, which afterwards came to be distinguished by the name Monte Somma. The whole of the forests, vineyards, and other luxuriant vegetation, which had covered that portion of the sides of Vesuvius where the eruption took place, were destroyed. Nothing could be more striking than the contrast between the beautiful appearance of the mountain before this catastrophe, and its desolate aspect after the sad event. This remarkable contrast forms the subject of one of Martial's Epigrams, lib. iv. Ep. 44. It is thus rendered by Mr. Addison:—

> "Vesuvius covered with the fruitful vine
> Here flourished once, and ran with floods of wine.
> Here Bacchus oft to the cool shades retired,
> And his own native Nysa less admired.
> Oft to the mountain's airy tops advanced,
> The frisking Satyrs on the summit danced.
> Alcides * here, here Venus graced the shore,
> Nor loved her favourite Lacedæmon more.
> Now piles of ashes, spreading all around,
> In undistinguished heaps deform the ground.
> The gods themselves the ruined seats bemoan,
> And blame the mischiefs that themselves have done."

Since the eruption of A.D. 79, Vesuvius has had many fits of activity with intervals of rest. In A.D.

* Hercules.

472, it threw out so great a quantity of ashes, that they overspread all Europe, and filled even Constantinople with alarm. In A.D. 1036 occurred the first eruption in which there was any ejection of lava. This eruption was followed by five others, the last of which occurred in 1500. To these succeeded a long rest of about a hundred and thirty years, during which the mountain had again become covered with gardens and vineyards as of old. Even the inside of the crater had become clothed with shrubbery.

In this interval, however, there was an extraordinary eruption—not of Vesuvius itself, but at no great distance from it, in the Bay of Baiæ, on the opposite shore of the Bay of Naples. The whole of this neighbourhood is a volcanic country, and was anciently named the Phlegræan Fields. It contains a crater in a state of subdued activity, called the Solfatara; an extinct volcano having a large crater called Monte Barbaro; and Lake Avernus, also supposed to be an extinct volcanic crater. Between Monte Barbaro and the sea, there was formerly a flat piece of ground bordering on the Lucrine Lake, which is separated from the Bay of Baiæ by a narrow strip of shingle. On the 29th of September 1538, the flat piece of ground above mentioned became the scene of a great eruption, which resulted in the throwing up of a new elevation to the height of four hundred and thirteen feet, and with a circumference of eight thousand feet. It received the name of Monte Nuovo, and is now covered with a luxuriant vegetation.

In 1631 there was another dreadful eruption of

Mount Vesuvius, which covered with lava most of the villages at the foot of the mountain. To add to the calamity, torrents of boiling water were, on this occasion, thrown out by the volcano, producing awful destruction.

There have been since that time numerous eruptions, which it would be tedious to mention in detail; but two of them are worthy of notice. During an eruption in February 1848, a column of vapours arose from the crater about forty feet high, presenting a variety of colours; and a short time afterwards there arose ten circles, which were black, white, and green, and which ultimately assumed the form of a cone. A similar appearance had been observed in 1820. More recently, in May 1855, a great stream of glowing lava, about two hundred feet in breadth, flowed towards a vast ravine nearly a thousand feet in depth. The first descent into this chasm is a sheer precipice, over which the lava dashed heavily, forming a magnificent cascade of liquid fire.

Of the buried cities of Herculaneum and Pompeii no traces were discovered till the year 1713, when some labourers, in digging a well, came upon the remains of Herculaneum about twenty-four feet underground. Little attention, however, was paid to the discovery at that time; but in 1748 a peasant, digging in his vineyard, stumbled on some ancient works of art. On sinking a shaft at this spot to the depth of twelve feet, the remains of Pompeii were found. This discovery led to further researches, and the exact positions of the two cities were erelong ascertained. The work of disinterment has continued

with little interruption from that to the present time, and many valuable specimens of ancient art have been brought to light.

The greatest progress has been made at Pompeii; because the stuff, in which it was buried, is far looser than that which covers Herculaneum. In the former city, although it was anciently reckoned only a third-rate place, there have already been discovered eight temples, a forum, a basilica, two theatres, a magnificent amphitheatre, and public baths. The ramparts, composed of huge blocks of stone, have also been exposed. One of the most remarkable places is the Cemetery. It consists of a broad path covered with pavement, and bordered on either side with stately monuments, placed over the tombs of the wealthy citizens of the place, and in which whole families have been interred.

The houses were found filled with elegant furniture, the walls of the apartments adorned with beautiful paintings. Numerous statues, vases, lamps, and other elegant works of art, have been recovered. Many skeletons have also been found, in the exact positions in which the living men were caught by the deadly shower of suffocating ashes. The excavators came upon the skeleton of a miser, who had been attempting to escape from his house, and whose bony fingers were still clutching the purse which contained the treasure he loved. There were also found in the barracks at Pompeii the skeletons of two soldiers chained to the stocks; and the writings scribbled by the soldiers on the walls are still quite legible. In the vaults of a villa in the suburbs were

discovered the skeletons of seventeen persons, who had probably sought refuge there, and been entombed. The stuff in which they were imbedded had been originally soft, but had become hardened through time. In this substance was found a cavity, containing the skeleton of a female with an infant in her arms. Although nothing but the bones remained, the cavity contained a perfect cast of the woman's figure—thus showing that she must have been imbedded in the substance while alive. Round the neck of this skeleton there was a gold chain, and on the fingers jewelled rings.

In many of the houses the names of the owners over the doors are still legible, and the fresco-paintings on the inner walls are still quite fresh and beautiful. The public fountains are adorned with shells formed into patterns; and in the room of a painter there was found a collection of shells in perfectly good order. A large quantity of fishing-nets was found in both the cities, and in Herculaneum some pieces of linen retaining its texture. There also was discovered a fruiterer's shop, with vessels full of almonds, chestnuts, carubs, and walnuts. In another shop stood a glass vessel containing moist olives, and a jar with caviare—the preserved roe of the sturgeon. In the shop of an apothecary stood a box that had contained pills, now reduced to powder, which had been prepared for a patient destined never to swallow them—a happy circumstance for him, if he eventually escaped from the city. Very recently there has been laid open a baker's shop, with the loaves of bread on the shelves, all ready for his cus-

tomers, but doomed never to be eaten. These loaves are of the same form as those still made in that country, and on being analyzed were found to consist of the same ingredients as modern bread.

Mount Vesuvius rises rather abruptly from the plain on which it stands. The circuit of the base is about twelve miles, and the height of the summit above the level of the sea about three thousand feet. This latter measurement, however, alters from time to time, owing to the variable height of the cone. Its moderate elevation, and the ease with which it may be approached, have induced many travellers to ascend the mountain; and not a few have recorded their experiences. So frequent are the eruptions of the volcano, however, and so much do they change the aspect of the crater, that any description remains correct for only a limited time.

Within the last hundred years the crater has been five times wholly altered, in consequence of its interior having been completely blown out, and its walls having crumbled down. When Sir William Hamilton ascended the mountain in 1756, it had no less than three craters and cones, one within another. The outermost was a very wide-mouthed cone. Within it rose centrically another, smaller in size and narrower in the mouth; and within that again was the third and highest, having a smaller base and still narrower opening at the top, whence the greatest volume of vapour ascended. In 1767 this innermost cone merged in the second, which was greatly enlarged; and by a subsequent eruption the interval between the first and second was obliterated, so that

only a single cone remained. In 1822 the whole interior of the cone was blown out, and its walls crumbled down, so as to lower the height of the mountain several hundred feet. But within the vast gulf, nearly a mile in diameter, which was thus left yawning open, there soon began to be formed a new cone, which showed itself erelong above the jagged edge of the crater. Eventually this cone increased, by the accumulation of ejected matters, to such an extent as to obliterate the division between it and the rim of the former crater—thus once more establishing a continuous cone. Since that time, the cone and crater have twice undergone similar changes.

The most usual appearance of the crater, when in comparative repose, is that of a vast circular or oval hollow basin, with nearly perpendicular walls, broken in their continuity, every here and there, by large projecting dykes, formed by the injection of more recent lavas into fissures rent in those which had previously become consolidated. Below the perpendicular walls is a rapid slope, composed of fine ashes or sand, descending to the floor of the crater, which is, for the most part, nearly flat. It is much rent by fissures, which during the night are seen to glow with a ruddy glare, emanating from the hot materials beneath, and giving to the floor the appearance of being overspread with a fiery tissue, like a spider's web. From the bottom there usually rise one or two small craters of eruption, whence continually issue sulphurous fumes, and which, at pretty regular intervals, discharge showers of stones heated to whiteness.

The exterior of the cone is composed entirely of loose cinders, ashes, and stones, so that the ascent is very laborious. The region of the mountain beneath the cone presents no difficulties, and that part of the ascent may be performed on donkeys or mules. The view from the top is magnificent. The contrast between the desolate aspect of the interior of the crater, and the smiling prospect which may be seen from its edge, has been well compared to looking out of Tartarus into Paradise.

Near Puzzuoli, in the Bay of Baiæ, and not far from Monte Nuovo, stand the ruins of the Temple of Serapis, so interesting to geologists. These remains, consisting chiefly of the shafts of three marble columns, still erect, though with a slight inclination sea-ward, afford distinct proofs, confirmed by other phenomena in the neighbourhood, that, since the beginning of the Christian era, the level of the coast in relation to that of the sea has changed twice —the land having first sunk and been then raised again, each time to the extent of upwards of 20 feet. The evidence of the submergence of the pillars consists mainly of a zone commencing at the height of about 12 feet above their pedestals, and extending 9 feet upwards, in which are numerous perforations, made by a marine bivalve mollusc. The upraising again of the ground on which the temple stands, to nearly its original height, appears to have occurred about the time of the formation of Monte Nuovo.

CHAPTER IV.

Mount Etna—Its Appearance and Height—Ancient Eruptions—Pindar's Allusion—Virgil's Description—Subordinate Cones and Craters—Caverns—Val del Bove—Formation of Monti Rossi—Eruption of 1852—Whirlwinds—Lava Torrents—Cascades of Lava—Description of Crater—Empedocles—Enceladus—Craters of 1865—Cyclopean Isles—Homer's Legend—Volcanic Origin—Other Basaltic Groups.

MOUNT ETNA may well be called the Queen of European Volcanoes, so majestic does she look, with her lofty summit glistening in the sunbeams white with snow, yet pouring forth volumes of vapour. This mountain, as you will observe from the annexed woodcut, is altogether more massive in its appearance than Vesuvius. It is about three times higher, rising to nearly eleven thousand feet above the level of the sea, and it has a circuit of about eighty-seven miles at its base.

Etna has been a volcano from time immemorial; but of its more ancient eruptions only vague traditions have survived. The Greek poet Pindar is the earliest writer who makes mention of its activity. He refers to it in his first Pythian Ode, Strophe B, l. 1. The passage is thus rendered by Carey:—

> "From whose caverned depths aspire,
> In purest folds upwreathing, tost
> Fountains of approachless fire—
> By day a flood of smouldering smoke
> With sullen gleam the torrents pour."

MOUNT ETNA.

The ode in which this allusion occurs is said to have been written about B.C. 470; and the eruption to which it refers probably took place shortly before that date.

Virgil also describes the mountain very forcibly in the Æneid, lib. iii. 570. Dryden renders the passage thus:—

> "The port capacious, and secure from wind,
> Is to the foot of thund'ring Etna joined.
> By turns a pitchy cloud she rolls on high:
> By turns hot embers from her entrails fly,
> And flakes of mounting flames, that lick the sky.
> Oft from her bowels massy rocks are thrown,
> And shivered by the force come piece-meal down.
> Oft liquid lakes of burning sulphur flow,
> Fed from the fiery springs that boil below."

Since the one to which Pindar alludes, there have been recorded about sixty eruptions; but in the present century Etna has been less frequently active than Vesuvius.

Owing to the great height of Mount Etna, the lava seldom rises so far as to flow from the summit. It more frequently bursts forth from the flanks of the mountain; and in this manner there have been formed numerous smaller cones, of which several have craters of their own. Hence Etna is rather a group of volcanoes than a single cone; but all these subordinate volcanic hills cluster round the flanks of the great central summit. Etna may thus be regarded as a fertile mother of mountains, with all her children around her. Some of these hills, her offspring, are covered with forests and rich vegetation—such having enjoyed a lasting repose. Others are still arid and bare, having been more recently formed.

Owing to this peculiarity in its structure, Etna does not present that conical aspect which characterizes most other volcanoes. Strange as it may seem, there are, on the sides of the mountain, caverns which the Sicilians use for storing ice. Some of these caverns are of vast extent. One called Fossa della Palomba measures, at its entrance, 625 feet in circumference, and has a depth of about 78 feet. This great cavity, however, forms merely the vestibule to a series of others, which are perfectly dark.

Another striking feature of Mount Etna is the Val del Bove. It is a deep valley, presenting, when viewed from above, somewhat of the appearance of an amphitheatre. It stretches from near the summit down to the upper limit of the wooded region of the mountain, and has a remarkably desolate aspect—presenting a vast expanse of bare and rugged lava.

Of the numerous eruptions of Etna, one of the most memorable was that of 1669, when on the flank of the mountain above Nicolosi, about half way between Catania and the top of the great crater, there was formed an immense rent about twelve miles long, from which a vast torrent of lava descended. After flowing for several miles, and destroying a part of Catania in its course, it entered the sea, and formed a small promontory, which has since proved very useful as a breakwater. But besides this stream, there were at the same time thrown up such immense quantities of ashes, cinders, stones, and other matters, that they formed two conical hills, more than three hundred feet in height above the slope of the mountain from which they rose, and measuring nearly two

miles in circumference at their base. These hills were named Monti Rossi.

Mount Etna was in activity as lately as 1865; but

CRATER OF ETNA.

a previous eruption in 1852 was of greater violence. It began, as usual, with hollow underground rumblings, and the ascent of dense columns of vapour, mingled

with dust and ashes, high into the air. These were speedily whirled into enormous eddies by fierce whirlwinds. Two new mouths were formed on the side of the mountain, and these vomited forth immense streams of lava, which rushed with the vehemence of a torrent down the steep. The violence of the commotion increasing, the two mouths were, by the crumbling of the intervening rocks, blended into one, and then huge fragments of the broken rock were hurled to a great height, along with vast quantities of hot stones, cinders, and black sand. Increasing quantities of lava were now poured from the greatly enlarged opening, and these formed on the plains below a great river of liquid fire, nearly two miles in breadth, and between seven and eight feet in depth, which advanced at the rate of upwards of a hundred feet in an hour, carrying before it devastation and ruin. Its course being through a highly cultivated country, the damage it inflicted was immense. This eruption continued for several months, with only short intervals of rest.

It has more than once happened, that the lava-streams of Etna, in their descent from the crater of eruption, have come to a precipitous wall of rock, over which they have plunged in a cascade similar to that formed by the lava of Vesuvius in 1855, but on a less magnificent scale, as respects the height of the fall. One of these occasions was during the eruption of 1771, and another during that of 1819.

The principal cone of Mount Etna was ascended in 1834 by Messrs. Elie de Beaumont and Leopold von Buch. The former describes what they saw in the

following terms:—"It was to us a moment of surprise difficult to describe, when we found ourselves unexpectedly on the margin—not, indeed, of the great crater—but of an almost circular gulf, nearly three hundred feet in diameter, which does not touch the great crater save at a small part of its circumference. We peered eagerly into this nearly cylindrical funnel; but vain was our search into the secret of its volcanic action. From the almost horizontal tops of the nearly vertical steeps, nothing can be descried but the upper cone. On trying to reckon those one below another, vision becomes gradually lost in the perfect darkness beneath. No sound issues from this darkness. There are only exhaled slightly sulphurous white vapours, chiefly steam. The dismal aspect of this black and silent gulf, in which our view was lost—its dark moist sides, along which crept, in a languid and monotonous manner, long flakes of vapour of a sombre gray—the great crater to which this narrow gulf is attached, with its confused heap of diverse substances, coloured yellow, gray, red, like the image of chaos—all presented around us an aspect quite funereal and sepulchral."

The French geologist, in having escaped from his visit to the crater with nothing worse than a fit of the vapours, came off better than Empedocles, the Sicilian philosopher, in the days of old: for, as the story goes, this inquisitive sage, being very anxious to have a peep into the crater, and venturing too near, toppled in altogether, and nothing more was seen of him, except one of his sandals, which was

vomited up by the volcano—thus conveying to his friends an intimation of the manner of his death.

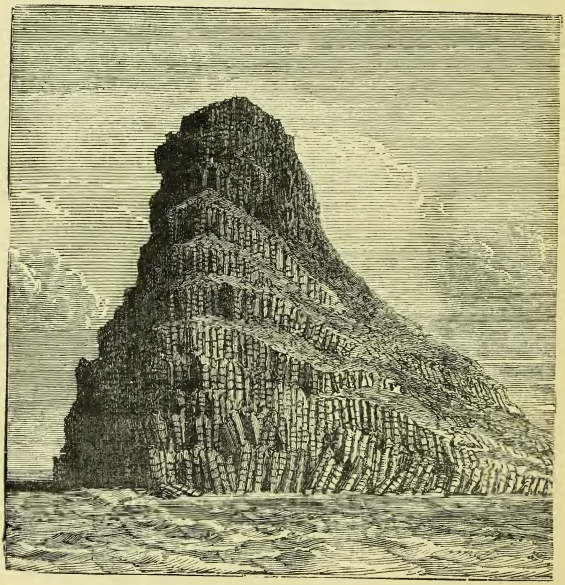
Some incredulous persons allege that this story has no better foundation than the fable of the poets, that the giant Enceladus, son of Titan and Terra, having offended Jupiter, the infuriated god first felled him with a thunderbolt, and then put Mount Etna as a sort of extinguisher on the top of him—his restlessness underneath fully accounting for all the commotions of the mountain.

Soon after the eruption which took place towards the end of January 1865, the craters then opened were visited by M. Fouqué, a French geologist. At the time of his visit, 10th March, they were seven in number, and he thus describes their modes of action:—

"The three upper craters produced two or three times a minute, powerful detonations like thunder-claps. The lower craters, on the contrary, incessantly gave forth a succession of reports too rapid to be reckoned. These sounds, although unremitting, were clear and distinct, the one from the other. I can find no better comparison for them than the strokes of a hammer falling on an anvil. Had the ancients heard a similar noise, I can readily conceive whence arose the idea of their imagining a forge in the centre of Etna, with the Cyclops for workmen."

Off the eastern coast of Sicily, and not far from Mount Etna, lie the Cyclopean Isles, of one of which the annexed woodcut gives a representation. You will observe what a singular appearance it presents, with its rows of basaltic columns piled one above another. The other isle is close by, and there is an

ancient tradition that they at one time formed part of the mainland of Sicily. Homer has a curious story about the manner in which they became detached. The passage occurs towards the end of the



CYCLOPEAN ISLE.

ninth book of the Odyssey. He tells that, at the time Ulysses visited Sicily, it was inhabited by the Cyclops, who, as already mentioned, were said to have had each only one eye, situated in his forehead. Their king's name was Polyphemus, a huge giant, who

beguiled Ulysses and a portion of his crew into a cave, where he killed some of the crew and devoured them for his supper. Ulysses, fearing his turn might come next, persuaded Polyphemus to taste some strong wine he had with him, and filled him so tipsy that he fell fast asleep. While he was in this state, Ulysses burnt out his one eye with a red-hot iron. The giant awoke in agony, but Ulysses contrived to escape from his clutches, and, after getting into his ship, began taunting and jeering the monster. Thereupon Homer says:—

> "These words the Cyclops' burning rage provoke:
> From the tall hill he rends a pointed rock;
> High o'er the billows flew the massy load,
> And near the ship came thund'ring on the flood.
> It almost brushed the helm, and fell before:
> The whole sea shook, and refluent beat the shore."
>
> POPE'S *translation.*

The huge missile having thus missed its mark, Ulysses, with great impudence, renewed his jeers, taunting the giant, and telling him who it was that had poked out his eye; whereupon Polyphemus invokes the vengeance of Neptune upon him, and—

> "A larger rock then heaving from the plain,
> He whirled it round—it rung across the main:
> It fell and brushed the stern: the billows roar,
> Shake at the weight, and refluent beat the shore."
>
> POPE'S *translation.*

The rocks of which the Cyclopean Isles are composed are entirely of volcanic origin, and it is far from improbable that they may have at one time been attached to Sicily, and severed from it by some great volcanic convulsion. A careful examination of these large piles of basaltic columns led Dr. Daubeny

to the conclusion, that the lavas from which they have been formed were consolidated under great pressure, and probably at the bottom of the sea, whence they have been afterwards upheaved. He also concludes, from certain appearances, that the two islands were at one time united.

The Cyclopean Isles strongly resemble, in their general aspect, the well-known Giant's Causeway on the northern coast of Ireland, and the Isle of Staffa off the western coast of Scotland. The latter, which, around its whole sea-girt outline, presents ranges of basaltic columns, some of them disposed in curious fantastic groups, most nearly resembles the Sicilian pair. These differ from it chiefly in their having the columns piled in terraces, one above another. Staffa, however, can boast of a far more striking feature—the celebrated Cave of Fingal—its stately basaltic columns inspiring every beholder with admiration, not unmixed with awe, while its brightly-tinted floor rivals in brilliancy of colouring the most beautiful mosaics.

In the Island of Iceland, also, there are some remarkable ranges of basaltic columns. One in particular, named the Ruins of Dverghamrar, is in the form of a semicircle skirting the sea-coast. Another group, still more wonderful, forms a curious natural Gothic arch, surmounted by pinnacles. It is so picturesque that an architect might study it with advantage, and derive from it valuable hints in designing the entrance to a cathedral.

CHAPTER V.

Lipari Islands—Stromboli—Origin of Name—Position of Crater—Description of Crater—New Volcanic Island named Julia—Phenomena preceding its Elevation—Description of Island and Crater—Its Disappearance—Rise of Islands at Santorin.

THE Lipari Islands are all of volcanic origin. The most interesting among them, for the length of time it has been in action and the constancy of its activity, is Stromboli. This name is a corruption of the ancient Greek name Στρογγύλη, which was given to it because of its round swelling form. This is a very fussy little volcano, for it keeps perpetually puffing, growling, and fuming. It throws out columns of steam, and at intervals stones, cinders, and ashes, which are for the most part drifted by the wind into the sea. This restless volcano has been in almost uninterrupted activity since at least the third century before the Christian era—however much further back.

Several enterprising travellers have ascended to the crater of Stromboli. It was examined with great care in 1828 by M. Hoffmann, a celebrated Prussian geologist, who, while being held fast by his companions, leant over the crag immediately above the crater, and looked right down into one of its active mouths. He thus describes what he saw:—

"Three active mouths were seen at the bottom of the crater. The principal one, in the middle, was about two hundred feet in diameter; it shows nothing remarkable, only fuming slightly; and numerous yellow incrustations of sulphur coat the walls of its chimney. Close by this mouth is another, somewhat nearer the precipice, only twenty feet wide, in which I could observe the play of the column of liquid lava, which at intervals poised itself at a level. This lava did not look like a burning mass vomiting flames, but as glossy as molten metal—like iron issuing from the smelting furnace, or silver at the bottom of a crucible.

"This melted mass rose and fell—evidently urged by the powerful tension of elastic vapours pressing it upwards from beneath; and it was easy to perceive the balance of effect between the weight of the molten masses and the pressure of the steam which resisted them. The surface rose and fell rhythmically: there was heard a peculiar sound, like the crackling of air from bellows entering the door of a furnace. A bubble of white vapour issued at each crack, raising the lava, which fell down again immediately after its escape. These bubbles of vapour dragged to the surface of the lava red-hot cinders, which danced as if tossed by invisible hands in rhythmic sport above the brink of the opening.

"This play, so regular and attractive, was interrupted, every quarter of an hour or so, by more tumultuous movements. The mass of whirling vapour then rested motionless for a moment—even making a jerking motion of return, as if inhaled by

JULIA, OR GRAHAM'S ISLAND, IN AUGUST 1831.

the crater, from the bottom of which the lava rose more strongly as if to encounter it. Then the ground trembles, and the walls of the crater starting bend. It was quite an earthquake. The mouth of the crater uttered a loud rolling bellow, which was followed by an immense bubble of vapour, bursting at the surface of the lava with a loud thundering report. The whole surface of the lava, reduced to glowing splinters, was then tossed into the air.

"The heat struck our faces forcibly; while a flaming sheaf rose right into the air, and fell back in a shower of fire all around. Some bombs ascended to a height of about 1200 feet, and in passing over our heads described parabolas of fire. Immediately after such an eruption, the lava withdrew to the bottom of the chimney, which then yawned black and gaping. But erelong there was seen re-ascending the shining mirror of the surface of lava, which then recommenced the rhythmic play of its ordinary less violent bubblings."

What an agreeable visit this must have been! Don't you think, between ourselves, that the German philosopher must, on this occasion, have greatly resembled an Irishman in love, seeing he was so eager to reach the mouth of the *crater?*

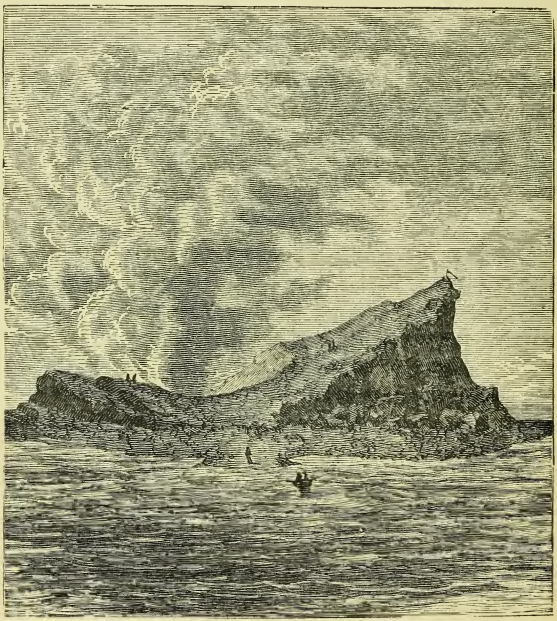
Before passing on to the description of other existing volcanoes, it may entertain you to hear something about Julia. This interesting *crater* had a short and troubled existence. She was not born like others of her name, but rose suddenly and majestically out of the sea, as the poets feign that Venus did of old. She did not, however, keep her

head long above water, but after raging and fuming for about a couple of months, she plunged again under the waves. This happened in the year 1831.

On page 57 is a picture showing you how she looked in August of that year, about a month after she made her appearance. You see what a fury of a *crater* she must have been. It was a French philosopher (Constant Prévost) who christened her Julia; but it is hard to divine what prompted him to act so ungallantly. Perhaps, at the moment, he may have had in his eye some Julia of his acquaintance, with very red hair and a very fiery temper.

This volcanic island rose out of the Mediterranean, about midway between the Island of Pantellaria and the village of Sciacca on the southern coast of Sicily. From about the 28th of June to the 2nd of July 1831, the inhabitants of Sciacca felt several slight shocks, which they imagined to have proceeded from Etna. On the 8th of July the crew of a Sicilian ship, which was sailing at a distance of about six miles from Sciacca, suddenly observed in the sea a jet of water about 100 feet high. It rose into the air with a thundering noise, sustained itself for about ten minutes, and then fell down. Similar jets continued to rise in succession, at intervals of about a quarter of an hour, and produced a thick mist overspreading the surface of the sea, which was much agitated and covered with a reddish scum. Shoals of dead fishes were drifted on the waves. On the third day the jets were between 800 and 900 feet in diameter, and between 60 and 70 feet in height, while the steam from them rose to nearly 1800 feet.

On the 12th of July the inhabitants of Sciacca had their nostrils assailed by a strong smell of sulphur, and beheld the surface of the sea covered with black



JULIA, OR GRAHAM'S ISLAND, ON 29TH SEPTEMBER 1831.

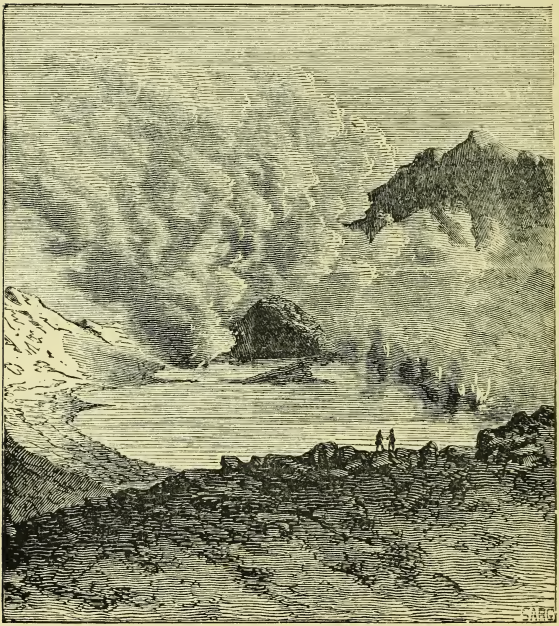
porous cinders, which, being drifted ashore, formed a bed of some thickness on the beach. So great was the drift of volcanic ashes, that boats could hardly struggle through the water, and multitudes

of dead fishes floated on its surface. Next morning they saw rising out of the sea a column of dark vapour, which, however, towards night became lurid red. From time to time, during both the day and night, they heard loud reports, and saw bright sparks of fire through the dusky vapour.

On the 18th of July the captain of the Sicilian ship discovered that an island had arisen out of the sea at the spot whence the appearances before described had proceeded. It had already attained a height of nearly twelve feet, and had in its centre a crater, which vomited forth immense jets of steam, along with ashes, cinders, stones, &c. The water which boiled in this crater was reddish, and the cinders, which covered the sea all round the island, were of a chocolate colour. The island subsequently attained a height of upwards of 90 feet at its highest point, and a circumference of about three-quarters of a mile. A channel of communication was also opened between the sea and the interior of the crater, which had a diameter of about 650 feet. The vapours and other matters thrown up from the mouth of the volcano formed a luminous column upwards of 200 feet in height.

On the 29th of September it was visited by the French gentleman who gave it the name of Julia, and it then presented the appearance which we have sketched. He landed with a party and proceeded to examine the crater, in which he found a circular basin filled with reddish water, almost boiling hot, and fresh. This basin was nearly 200 feet in diameter. There rose from the water bubbles of gas, which made

it appear as if it were boiling. The water was not quite at the boiling point, however, yet the bubbles of gas were sufficiently hot to burn the fingers.



CRATER OF JULIA, OR GRAHAM'S ISLAND.

These bubbles rose from a great depth, and each, on bursting, which it did with a feeble report, threw out sand and cinders. At a short distance from the crater there rose sulphurous vapours, which deposited

sulphur and salt. The loose dust and ashes forming the soil of the island were hot, and walking on them was difficult. The foregoing woodcut will give you an idea of the appearance which the crater presented to those visitors.

In the following month of October nothing remained of this wonderful island but a hillock of sand and cinders; and at the end of six months it had quite vanished. Soundings taken a few years ago show ten feet of water over the spot, so that, although the island has disappeared, there is still a shoal left behind. This temporary volcano is best known in England under the name of Graham's Island; so called after an English naval officer of that name, who was the first to set foot on it, and who planted upon it the English flag, so claiming it for his sovereign. The Sicilians allege this to be the reason why it disappeared so soon—that it was in a hurry to escape from under the English yoke.

Similar phenomena have been taking place during the past year, 1866, in the Bay of Santorin, situated in the island of that name, which lies to the northward of Crete. There are several islands in the bay, all apparently of volcanic origin, and one of them was thrown up about three centuries before the beginning of the Christian era. Last year their number was increased by a series of eruptions similar in their attendant circumstances to those which accompanied the upheaval of Julia. The first warnings were given on the 30th of January 1866, by low underground rumblings, and slight movements of the ground at the south end of New Kammeni, one of

the formerly upheaved islands in the bay. Next day these phenomena increased in violence, and quantities of gas bubbled up from the sea. On the 1st of February, reddish flames ascended from the water, and on the 2nd there rose, out of the harbour of Voulcano, an island, which was christened "George." The volcanic agitation was prolonged during February and March—the upheaval of other two islands being the result. Whether these additional islands will continue permanently above water remains to be seen.

CHAPTER VI.

Peak of Teneriffe—Its Crater—Eruption of Chahorra—Palma—Great Caldera—Lancerote—Great Eruption—Sudden Death—Fuego, Cape de Verde Islands—Cotopaxi—Its Appearance—Great Eruptive Force—Tunguragua—Great Eruption of Mud and Water—Fish thrown out—Quito—Its Overthrow—Pichinca—Humboldt's Ascent—Narrow Escape—Antisana—Sangay—Rancagua—Chillan—Masaya.

THE Island of Teneriffe is celebrated for its magnificent snow-clad peak. On referring to the woodcut of this volcano at page 11, you will observe in what a sharp point the cone terminates, and how slender is the column of vapour at its summit. The crater at the top is comparatively small—its greatest diameter being 300, and its smallest 200 feet, while its depth is only about 100 feet. From this crater there has been no eruption since 1706, when the finest harbour in the island was destroyed. But from the side of the peak there rises a supplementary mountain named Chahorra, on the top of which there is also a crater, whence there was an eruption in 1798. So great was its violence, that masses of rock were thrown to a height of upwards of 3000 feet. In the neighbouring island of Palma there is a volcanic crater named the Great Caldera, whose depth is said to be upwards of 5000 feet.

Almost due east of Palma, and much nearer the African coast, lies the Island of Lancerote, on which are a great many volcanic cones, arranged nearly in a straight line. These were for the most part formed by a long series of eruptions which took place during the years from 1730 to 1736. Such immense quantities of lava were poured forth in the course of those six years, that about a third of the surface of the island was covered by them, and many towns and villages were destroyed. St. Catalina, a populous and thriving town, was first overflowed by a lava-stream, and then a new crater burst forth on its very site, raising over it a hill 400 feet high. All the cattle in the island fell down dead in one day, and nearly about the same time—they were suffocated by deadly vapours that rose from the ground. The volcanic activity of this island was renewed in August 1824, when there was formed, near the port of Rescif, a new crater, which vomited forth such quantities of stones, ashes, and other volcanic matters, that in the short space of twenty-four hours they formed a hill of considerable height.

The Cape de Verde Islands, lying to the south-westward of the Canaries, are also volcanic. In 1847 a volcano named Fuego, situated in one of them, after remaining at rest about fifty years, burst into fresh activity. No less than seven new vents were formed; and from these were poured forth great streams of lava, which wrought immense damage in the cultivated parts of the island. The inhabitants sustained great loss by the destruction of their cattle and crops.

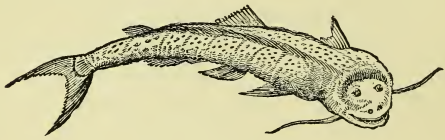
Passing over to the South American continent, we come to the range of the Andes, which contains numerous volcanoes. Among these the most conspicuous is Cotopaxi, the highest volcano in the world, situated in the territory of Quito. So perfect is the form of the cone, that it looks as if it had been turned in a lathe. Its coating of snow gives it a dazzling appearance, and so sharply is the snow-line defined that it seems almost as if the volcano-king wore a white night-cap instead of a crown.

The eruptions of this mountain are rare. One of the greatest of them lasted for three years, and desolated an immense extent of country with floods of lava. On this occasion, it is said, columns of fire rose to the height of nearly 5000 feet, so great was the energy of the volcanic force.

A little to the southward of Cotopaxi, but concealed from it by the intervening mass of Chimborazo, lies the volcano of Tunguragua, from which there was an extraordinary eruption in the year 1797, that proved very destructive to the cities in its neighbourhood. Indeed, so terrible was the convulsion of the ground, which lasted four minutes, that the cities of Riobamba and Quero were reduced to heaps of ruins. Then the base of Tunguragua was rent, and from numerous apertures there were poured out streams of water and mud, the latter gathering in the valleys to the depth of 600 feet. This mud spread itself far and wide, blocking up the channels of rivers, and forming lakes, which remained upwards of two months. But, strangest of all, quantities of dead fishes were found in the water which burst from

the volcano. These fishes are supposed to have been bred in subterranean lakes contained in caverns in the interior of the mountain, considerably removed from the volcanic fires in the centre. It is probable that, when the rent was formed near the base, one of those caverns was broken open, and that the waters from it were discharged along with their finny inhabitants.

Here is a picture of one of those fishes, which was taken by Baron Humboldt. When you see what



PIMELODUS CYCLOPUM.

a queer-looking fish it is, you will wonder the less at its having chosen so strange an abode.

Quito, the capital of the province of that name, is the highest of cities—being situated at an elevation of between nine and ten thousand feet above the level of the sea. It is built on a plain, lying on the flanks of the volcano Pichinca, of which a view is given in the annexed woodcut. Poor Quito has suffered severely from this dangerous neighbourhood; for, on the 22nd of March 1859, a violent shaking of the mountain laid the whole city in ruins.

Pichinca, you will observe, has a most irregular outline, but very graceful withal. Instead of a single cone like Cotopaxi, it has a group of cones, some of

PICHINCA.

which are very pointed. It has four principal summits, of which the most southerly contains the active crater. Here the celebrated traveller Baron Humboldt nearly lost his life. Having ascended the cone and approached the edge of the crater, he peered into the depths of the dark abyss, and there beheld the glowing lava boiling as if in a huge caldron. A thick mist coming on, he unwarily advanced to within a few feet of the rapid slope descending into the crater, and was within an ace of toppling over into the fiery gulf beneath. What a pity it would have been had he fallen in! We should have had no "Personal Narrative," no "Cosmos."

There are in this region of South America other two great volcanoes, named Antisana and Sangay. The former has not been in action since 1718, but is remarkable for the immense beds of lava which it has amassed around it during its former eruptions. Sangay, again, has ever since 1728 been in a state of almost perpetual activity—in this respect resembling Stromboli, which, however, it far exceeds in height, its summit being nearly 18,000 feet above the level of the sea. The eruptions of this mountain are accompanied by loud explosions, which are heard at great distances, and they succeed each other with immense rapidity. The fumes emitted are sometimes gray, sometimes orange; and the matters ejected are cinders, dross, and spherical masses of stone. These last are often two feet in diameter, and in strong explosions as many as sixty of them may be thrown out at a time. They are glowing at a white heat, and for the most part they fall back into the vent of

the crater. Sometimes, however, they alight on the edge of the cone—imparting to it a temporary brilliancy; but the mass of the cone, being composed of loose black cinders, has a most dismal aspect.

Another very active South American volcano is Rancagua in Chili. It is, however, of moderate height, and thus in its general character resembles Stromboli, which it rivals in restlessness. Another of the volcanoes of Chili, named Chillan, which had long been in a state of repose, renewed its activity in November 1864. Its usually snow-clad summit became covered in a short time with a thick layer of volcanic ashes, which greatly altered its appearance. Streams of lava were also thrown out by the mountain on this occasion.

There are several volcanoes in Central America. One of them, named Masaya, was very active during the sixteenth century. It is situated near the lake of Nicaragua, in the territory of that name. It was visited in 1529 by the Spanish historian Gonzales Fernando de Oviedo, from whose description it seems to have presented phenomena resembling those seen in the crater of Stromboli. "In its ordinary state," he says, "the surface of the lava, in the midst of which black scoriæ are continually floating, remains several hundred feet below the edges of the water. But sometimes there is suddenly produced an ebullition so violent, that the lava rises almost to the very brim."

CHAPTER VII.

Jorullo—Great Monument — Jorullo's Estate—Interruption to his Quiet—His Estate Swells — Swallows Two Rivers—Throws up Ovens—Becomes a Burning Mountain—Popocatepetl—Spanish Ascents — Orizaba — Müller's Ascent — Morne-Garou—Pelée—La Soufrière.

WHAT a fortunate man was Mr. Jorullo! Old Cheops, king of Egypt, spent vast sums of money, many long years, and the labour of myriads of his subjects, in erecting the Great Pyramid as a monument to his memory. But Mr. Jorullo, without his having to lay down a single Mexican dollar, and without any labour, either of his own or of his servants, had a magnificent monument raised to his memory in a single night. Jorullo's monument, too, is far bigger than the pyramid of Cheops—being nearly four times the height, and occupying a much larger extent of ground. Whether it will last as long as the pyramid has done, time only can show.

You would doubtless like to know how this great monument was reared. Here is the story:—Don Pedro di Jorullo was a Mexican gentleman who lived about the middle of the last century. He was a landed proprietor—the owner of a nice little farm of great fertility, situated to the westward of the city of Mexico, and about ninety miles from the coast of the Pacific Ocean. The ground was well watered by arti-

JORULLO.

ficial means, and produced abundant crops of indigo and sugar-cane. Thus Mr. Jorullo was a very thriving well-to-do sort of man.

This gentleman's prosperity continued without interruption till the month of June 1759, when, to the great alarm of his servants dwelling on the estate, strange underground rumblings were heard, accompanied by frequent shakings of the ground. These continued for nearly two months; but at the end of that time all became quiet again, and Mr. Jorullo's servants slept in fancied security. On the night of the 28th of September, however, their slumbers were suddenly broken by a return of the horrible underground rumblings—thundering more loudly than before. The next night, these subterranean thunders became so loud, that the Indian servants started from their beds, and fled in terror to the mountains in the neighbourhood. Gazing thence, after day had dawned, they beheld to their astonishment that a tract of ground from three to four square miles in extent, with their master's farm in the middle of it, had been upheaved in the shape of an inflated bladder. At the edges this singular elevation rises only about thirty-nine feet above the old level of the plain; but so great is the general convexity of the mound, that towards the centre it swells up to five hundred and twenty-four feet above the original level.

The Indians affirmed that they saw flames issue from the ground throughout an extent of more than half a square league, while fragments of burning rocks were thrown to enormous heights. Thick clouds of ashes rose into the air, illuminated by glowing

fires beneath; and the surface of the ground seemed to swell into billows, like those of a tempestuous sea. Into the vast burning chasms, whence these ejections were thrown, two rivers plunged in cataracts; but the water only increased the violence of the eruption. It was thrown into steam with explosive force, and great quantities of mud and balls of basalt were ejected. On the surface of the swollen mound there were formed thousands of small cones, from six to ten feet in height, and sending forth steam to heights varying from twenty to thirty feet.

Out of a chasm in the midst of these cones, or ovens, as the natives call them, there rose six large masses, the highest of which is sixteen hundred feet in height, and constitutes the volcano of Jorullo. The eruptions of this central volcano continued till February 1760 with extreme violence—the crater throwing out large quantities of lava; but in the succeeding years it became less turbulent in its activity. It still, however, continues to burn; and the mountain emits from the wide crater at its summit several jets of vapour. The foregoing woodcut gives a view of this volcano, and of the little steaming ovens which stud the whole ground around it, giving it at a distance the appearance of the sea in a storm. And now confess that Mr. Jorullo's monument is far grander than the pyramid of Cheops. Surely the loss of his farm was amply compensated to him, by the perpetuation of his memory and his name, through the rearing of such a marvellous cenotaph.

For a long time after the first eruption, the ground

for a great distance round the volcano was too hot to be habitable or capable of cultivation. It is now, however, so much cooled down, that it is once more covered with vegetation; and even some small portions of the raised ground containing the ovens have been again brought under culture.

Besides this volcano, so recent in its origin, Mexico contains other five—Orizaba, Toluca, Tuxtla, Popocatepetl, and Colima. What is rather remarkable, these five, together with Jorullo, all lie nearly in a straight line running east and west. The tracts of country which these volcanoes have desolated with their lavas are called by the Mexicans the "Malpays."

The most remarkable of these mountains is Popocatepetl. Although it has long remained in comparative quiet, it was very active at the time of the Spanish invasion under Cortés. Of the first approach of the Spaniards to this volcano, and of the attempts made by some of them to climb to the top, Mr. Prescott, in his history of the conquest of Mexico, gives the following graphic account:—

"They were passing between two of the highest mountains on the North American continent, Popocatepetl, 'the hill that smokes,' and Iztaccihuatl, or 'white woman;' a name suggested, doubtless, by the bright robe of snow spread over its broad and broken surface. A puerile superstition of the Indians regarded these celebrated mountains as gods, and Iztaccihuatl as the wife of her more formidable neighbour. A tradition of a higher character described the northern volcano as the abode of the departed spirits of wicked rulers, whose fiery agonies

in their prison-house caused the fearful bellowings and convulsions in times of eruption. It was the classic fable of antiquity. These superstitious legends had invested the mountain with a mysterious horror, that made the natives shrink from attempting its ascent, which, indeed, was, from natural causes, a work of incredible difficulty.

"The great *volcan*, as Popocatepetl was called, rose to the enormous height of 17,852 feet above the level of the sea; more than 2000 feet above the 'monarch of mountains'—the highest elevation in Europe. During the present century it has rarely given evidence of its volcanic origin, and 'the hill that smokes' has almost forfeited its claim to the appellation. But at the time of the conquest it was frequently in a state of activity, and raged with uncommon fury while the Spaniards were at Tlascala; an evil omen, it was thought, for the natives of Anahuac. Its head, gathered into a regular cone by the deposit of successive eruptions, wore the usual form of volcanic mountains, when not disturbed by the falling in of the crater. Soaring towards the skies, with its silver sheet of everlasting snow, it was seen far and wide over the broad plains of Mexico and Puebla; the first object which the morning sun greeted in his rising, the last where his evening rays were seen to linger, shedding a glorious effulgence over its head, that contrasted strikingly with the ruinous waste of sand and lava immediately below, and the deep fringe of funereal pines that shrouded its base.

"The mysterious terrors which hung over the spot,

and the wild love of adventure, made some of the Spanish cavaliers desirous to attempt the ascent, which the natives declared no man could accomplish and live. Cortês encouraged them in the enterprise, willing to show the Indians that no achievement was above the dauntless daring of his followers. One of his captains, accordingly, Diego Ordaz, with nine Spaniards, and several Tlascalans, encouraged by their example, undertook the ascent. It was attended with more difficulty than had been anticipated.

"The lower region was clothed with a dense forest, so thickly matted, that in some places it was scarcely possible to penetrate it. It grew thinner, however, as they advanced, dwindling by degrees into a straggling stunted vegetation, till, at the height of somewhat more than 13,000 feet, it faded away altogether. The Indians, who had held on thus far, intimidated by the strange subterraneous sounds of the volcano, even then in a state of combustion, now left them. The track opened on a black surface of glazed volcanic sand and of lava, the broken fragments of which, arrested in its boiling progress in a thousand fantastic forms, opposed continual impediments to their advance. Amidst these, one huge rock, the Pico del Fraile, a conspicuous object from below, rose to the perpendicular height of 150 feet, compelling them to take a wide circuit. They soon came to the limits of perpetual snow, where new difficulties presented themselves, as the treacherous ice gave an imperfect footing, and a false step might precipitate them into the frozen chasms that yawned around. To increase their distress, respiration in these aërial

regions became so difficult, that every effort was attended with sharp pains in the head and limbs. Still they pressed on, till, drawing nearer the crater, such volumes of smoke, sparks, and cinders were belched forth from its burning entrails, and driven down the sides of the mountain, as nearly suffocated and blinded them. It was too much even for their hardy frames to endure, and, however reluctantly, they were compelled to abandon the attempt on the eve of its completion. They brought back some huge icicles—a curious sight in those tropical regions—as a trophy of their achievement, which, however imperfect, was sufficient to strike the minds of the natives with wonder, by showing that with the Spaniards the most appalling and mysterious perils were only as pastimes. The undertaking was eminently characteristic of the bold spirit of the cavalier of that day, who, not content with the dangers that lay in his path, seemed to court them from the mere Quixotic love of adventure. A report of the affair was transmitted to the Emperor Charles V.; and the family of Ordaz was allowed to commemorate the exploit by assuming a burning mountain on their escutcheon.

"The general was not satisfied with the result. Two years after he sent up another party, under Francisco Montaño, a cavalier of determined resolution. The object was to obtain sulphur to assist in making gunpowder for the army. The mountain was quiet at the time, and the expedition was attended with better success. The Spaniards, five in number, climbed to the very edge of the crater,

which presented an irregular ellipse at its mouth, more than a league in circumference. Its depth might be from 800 to 1000 feet. A lurid flame burned gloomily at the bottom, sending up a sulphureous steam, which, cooling as it rose, was precipitated on the sides of the cavity. The party cast lots, and it fell on Montaño himself to descend in a basket into this hideous abyss, into which he was lowered by his companions to the depth of 400 feet! This was repeated several times, till the adventurous cavalier had collected a sufficient quantity of sulphur for the wants of the army."

The more tranquil state of the volcano in modern times having rendered the summit no longer so difficult of access as it was in those days, the ascent has been several times achieved—twice in 1827, and again in 1833 and 1834. The crater is now a large oval basin with precipitous walls, composed of beds of lava, of which some are black, others of a pale rose tint. At the bottom of the crater, which is nearly flat, are several conical vents, whence are continually issuing vapours of variable colour, red, yellow, or white. The beds of sulphur deposited in this crater are worked for economical purposes. Two snowy peaks tower above its walls.

Not less magnificent in its proportions is the volcano of Orizaba, which is nearly of the same height as Popocatepetl. It was very active about the middle of the sixteenth century, having had several great eruptions between 1545 and 1560; but since then it has sunk into comparative repose. This mountain was ascended by Baron Müller in 1856. A first

attempt proved unsuccessful; but by passing a night in a grotto near the limit of perpetual snow, he was able on the following day, after a toilsome ascent, to reach the edge of the crater—not, however, till near sunset. His experiences, and the scene which was presented to his wondering gaze, he describes in the following terms:—

"I have achieved my purpose, and joy banishes all my griefs, but only for a moment; suddenly I fell to the ground, and a stream of blood gushed from my mouth.

"On recovering, I found myself still close to the crater, and I then summoned all my strength to gaze and observe as much as possible. My pen cannot describe either the aspect of those regions, or the impressions they produced on me. Here seemed to be the gate of the nether world, enclosing darkness and horror. What terrible power must have been required to raise and shiver such enormous masses, to melt them and pile them up like towers, at the very moment of their cooling and acquiring their actual forms!

"A yellow crust of sulphur coats in several places the internal walls, and from the bottom rise several volcanic cones. The soil of the crater, so far as I could see, was covered with snow, consequently not at all warm. The Indians however affirmed that, at several points, a hot air issues from crevices in the rocks. Although I could not verify their statement, it seemed to me probable; for I have often observed similar phenomena in Popocatepetl.

"My original intention of passing the night on the

crater had for overpowering reasons become impracticable. The twilight which, in this latitude, as every one knows, is extremely short, having already begun, it was necessary to prepare for our return. The two Indians rolled together the straw mats which they had brought, and bent them in front so as to form a sort of sledge. We sat down upon these, and stretching out our legs, allowed ourselves to glide down on this vehicle. The rapidity with which we were precipitated increased to such a degree, that our descent was rather like being shot through the air, than any other mode of locomotion. In a few minutes we dashed over a space which it had taken us five hours to climb."

There are several of the West Indian islands of volcanic origin; and three of them—St. Vincent, Martinique, and Guadaloupe—contain active volcanoes. The most remarkable is the volcano of Morne-Garou, in St. Vincent, the eruptions from which have been particularly violent. In 1812 the ashes which it threw out were so great in quantity, and projected to so vast a height, that they were carried to a distance of two hundred miles in the teeth of the trade-wind. From Mount Pelée, in Martinique, there was an eruption in August 1851. La Soufrière, the volcano in Guadaloupe, is said to have been cleft in twain during an earthquake. Its activity has long been in a subdued state; but it is remarkable for its deposits of sulphur.

CHAPTER VIII.

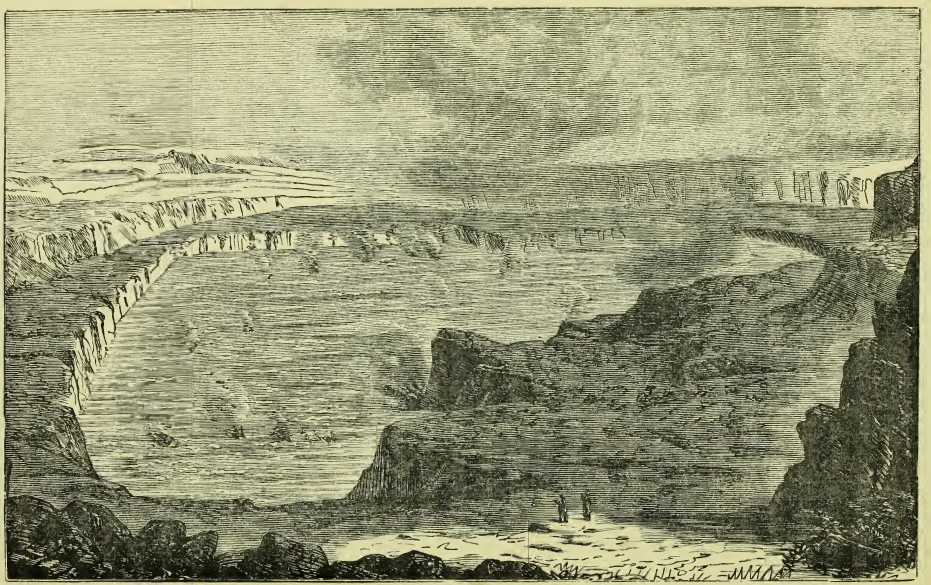
Hawaii, Sandwich Islands—Crater of Kilauea—Its awful Aspect—Fiery Lake and Islands—Jets of Lava—Depth of Crater and Surface of Lake—Bank of Sulphur—Curious Rainbow—Mouna-Kaah and Mouna-Loa—Eruption of the Latter in 1840—Recent Eruption—Great Jet and Torrent of Lava—Burning of the Forests—Great Whirlwinds—Underground Explosions—Other Volcanoes in the Pacific.

HAWAII is well known in history as being the island where the celebrated navigator Captain Cook was killed. The name used to be written Owhyhee; but a better apprehension of the native pronunciation has led to its being altered into Hawaii. No one who visits it in the present day need be afraid of sharing the fate of poor Captain Cook; for the descendants of the savages who, in his time, inhabited the island, have now, through the labours of Christian missionaries, become a very decent sort of quiet, well-behaved Christian people.

Hawaii, which is the largest of a group called the Sandwich Islands, can boast of the greatest volcanic crater in the world. It is called sometimes Kirauea, sometimes Kilauea; for the natives seem not very particular about the pronunciation of their *l* and their *r;* but where one uses *l* another as pertinaciously employs *r*, while a third set use a sound between the two, as you may have heard some people do at

home. Situated on the lower slopes of a lofty mountain called Mouna-Roa, or Loa (for there is the same dubiety about the *l* and the *r* here as in the former case), the crater of Kilauea is a vast plain between fifteen and sixteen miles in circumference, and sunk below the level of its borders to a depth varying from two hundred to four hundred feet—the walls of rock enclosing it being for the most part precipitous. The surface of the ground is very uneven, being strown with huge stones and masses of volcanic rock, and it sounds hollow under the tramp of the foot.

Towards the centre of the plain is a much deeper depression. Those who have ventured to approach it, and look down, describe it as an awful gulf, about eight hundred feet in depth, and presenting a most gloomy and dismal aspect. The bottom is covered with molten lava, forming a great lake of fire, which is continually boiling violently, and whose fiery billows exhibit a wild terrific appearance. The shape of the lake resembles the crescent moon; its length is estimated at about two miles, and its greatest breadth at about one mile. It has numerous conical islands scattered round the edge, or in the lake itself, each of them being a little subordinate crater. Some of them are continually sending out columns of gray vapour; while from a few others shoots up what resembles flame. It is, probably, only the bright glare of the lava they contain, reflected upwards. Several of these conical islands are always belching forth from their mouths glowing streams of lava, which roll in fiery torrents down their black and rugged sides into the boiling lake below. They are said



CRATER OF KILAUEA.

sometimes to throw up jets of lava to the height of upwards of sixty feet. The foregoing woodcut can convey only an imperfect idea of this immense crater.

The outer margin of the gulf all round is nearly perpendicular. The height of the bounding cliffs is estimated at about four hundred feet above a black horizontal ledge of hardened lava, which completely encircles it, and beyond which there is a gradual slope down into the burning lake. The surface of the molten lava is at present between three and four hundred feet below this horizontal ledge; but the lava is said sometimes to rise quite up to this level, and to force its way out by forming an opening in the side of the mountain, whence it flows down to the sea. An eruption of this kind took place in 1859. On one side of the margin of the lake there is a long pale yellow streak formed by a bank of sulphur. The faces of the rocks composing the outer walls of the crater have a pale ashy gray appearance, supposed to be due to the action of the sulphurous vapours. The surface of the plain itself is much rent by fissures. It is said that the glare from the molten lava in the lake is so great as to form rainbows on the passing rain-clouds.

The entire Island of Hawaii is of volcanic origin; and besides this great crater it contains two other lofty mountains, whose summits are covered with snow, and whose height is estimated at fifteen or sixteen thousand feet above the level of the sea. The one is named Mouna-Kaah or Keah, the other is Mouna-Loa—the same on whose lower flanks the crater of Kilauea is situated. Mouna-Kaah has long

been in a state of repose. So also was Mouna-Loa up to 1840, when it burst forth with great fury, and it has continued more or less in a state of activity ever since. There has been a grand eruption very lately, said by the natives to have been the greatest of any on record.

A new crater opened near the top, at a height of about ten thousand feet, and for three days a flood of lava poured down the north-eastern slope. After a pause of about thirty-six hours, there was opened on the eastern slope, about half way down the mountain, another crater, whence there rose an immense jet of liquid lava, which attained a height of about a thousand feet, and had a diameter of about a hundred feet. This jet was sustained for twenty days and nights; but during that time its height varied from the extreme limit of a thousand, down to about a hundred feet. The play of this fiery fountain was accompanied by explosions so loud as to be heard at the distance of forty miles. Nothing could surpass the awful grandeur of this jet, which was at a white heat when it issued from its source, but, cooling as it ascended into the air, it became of a bright blood red, which, as the liquid fell, deepened into crimson.

In a few days there was raised around this crater a cone of about three hundred feet in height, composed of the looser materials thrown out along with the lava. This cone continued to glow with intense heat, throwing out occasional flashes. The base of this cone eventually acquired a circumference of about a mile. But the fountain itself formed a river of glowing lava, which rushed and bounded with the

speed of a torrent down the sides of the mountain, filling up ravines and dashing over precipices, until it reached the forests at the foot of the volcano. These burst into flames at the approach of the fiery torrent, sending up volumes of smoke and steam high into the air. The light from the burning forests and the lava together was so intense as to turn night into day, and was seen by mariners at a distance of nearly two hundred miles.

During the day the air throughout a vast extent was filled with a murky haze, through which the sun showed only a pallid glimmer. Smoke, steam, ashes, and cinders were tossed into the air and whirled about by fierce winds—sometimes spreading out like a fan, but every moment changing both their form and colour. The stream of lava from the fountain flowed to a distance of about thirty-five miles. The scene was altogether terrific—the fierce red glare of the lava—the flames from the burning trees—the great volumes of smoke and steam—the loud underground explosions and thunderings,—all combined to overpower the senses, and fill the mind with indescribable awe.

A remarkable volcanic chain runs along the northern and western margins of the Pacific Ocean. It embraces the Aleutian Islands, the peninsula of Kamtschatka, the Kurile, the Japanese, and the Philippine Islands. The most interesting are the volcanoes of Kamtschatka, in which there is an oft-renewed struggle between opposing forces—the snow and glaciers predominating for a while, to be in their turn overpowered by torrents of liquid fire.

CHAPTER IX.

Atolls, or Coral Islands—Their strange Appearance—Their Connexion with Volcanoes—Their Mode of Formation—Antarctic Volcanoes—Diatomaceous Deposits.

TO the southward of the Sandwich Islands, on the other side of the equator, there is a large group of islands in the Pacific, which have a very peculiar appearance. They are called Atolls or Coral Islands. Although not exactly of volcanic origin, yet the manner in which they are formed has some connexion with submarine volcanic action.

An atoll consists essentially of a ring of coral rocks but little elevated above the level of the sea, and having in its centre a lagoon or salt-water lake, which generally communicates by a deep narrow channel with the sea. The ring of rocks is flat on the surface, which is composed of friable soil, and sustains a luxuriant vegetation, chiefly of cocoa-nut palms. It is seldom more than half a mile in breadth between the sea and lagoon, sometimes only three or four hundred yards. The outer margin of the ring is the highest, and it slopes gradually down towards the lagoon; but on the outside of the ledge of rocks is a beach of dazzling whiteness, composed of powdered and broken coral and shells. The ap-

pearance they present is thus not less beautiful than singular. Some of these islands are of large size, from thirty to fifty miles long, and from twenty to thirty broad, but they are in general considerably smaller. Their most frequent form is either round or oval. The rocks composing them are all formed by different species of coral. The animal which

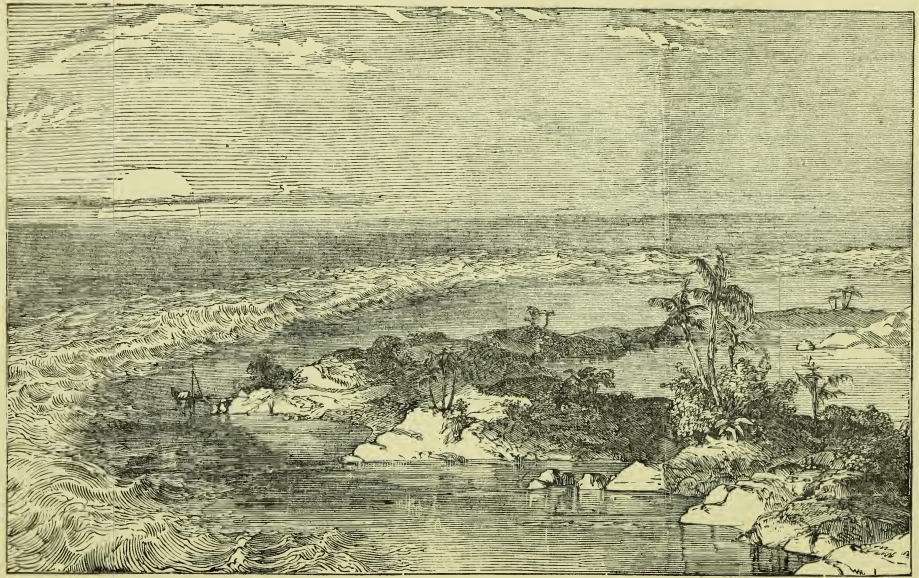
CORAL.

CORAL POLYP.

constructs them is of the polyp tribe, and so small that it can be seen only under the higher powers of the microscope. It multiplies by means of buds like those of a tree, the individuals all combining to form a composite stony mass, which is called a polypidom. A number of such polypidoms growing close together form a coral reef. See woodcuts.

It was at one time supposed that these coral reefs were erected on the edges of the craters of submarine volcanoes, an opinion to which their annular form, and the lagoon in the centre, lent some countenance; but the vast size of some of them, united to several other particulars connected with them, threw great doubts over this supposition.

More recently it has been shown by Mr. Darwin that, while volcanic agency does perform a part in their formation, it is different from what had been formerly imagined. His supposition is, that these

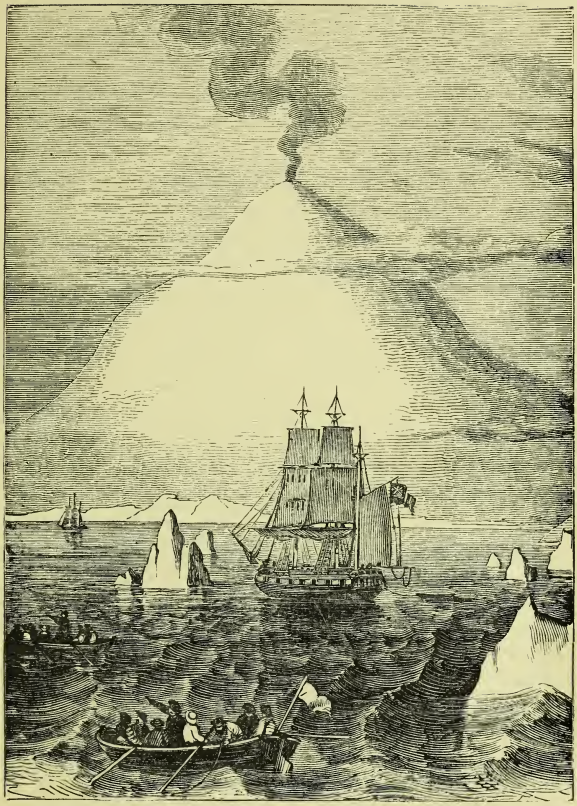


CORAL REEF.

coral reefs were built round the coasts of islands which had once stood very much higher above water than they do now. He conceives that the bottom of the sea under them being very volcanic, and containing large collections of molten lava beneath a thin solid crust, the islands have gradually sunk down into the lava, until their central parts have become covered with a considerable depth of water. The central parts thus submerged, he imagines, form the lagoons in the middle of the islands, while the ring of coral reefs has gradually grown upwards, as the ground on which it rested sank downwards.

The corals thus rise to near the surface, but immediately on their being uncovered by the water they die, and the reef ceases to grow. Then the waves by their action break the upper part of it into pieces, which thus become heaped up by degrees on the remainder, until the mass attain so great a height that the sea can no longer wash over it. Thus the curious ring of land is gradually formed, and affords a nutritive soil, in which cocoa-nuts, on being cast ashore, germinate and grow to be large trees. Other seeds, wafted by the waves or carried by birds, also begin to grow, until the whole surface becomes covered with vegetation. Then comes man and builds his habitation upon those fertile spots, and finds in them an agreeable and convenient abode, well suited to those who are accustomed to live by fishing and other simple means.

You will thus perceive that the connexion between the atoll and the volcano consists in this—that while the coral builds up the reef, the volcano beneath



MOUNT EREBUS.

ingulfs the island and causes it to sink down. In some instances, however, the volcano, after a while,

reverses its action, and raises up the island with the reef upon it. In such cases, the coral reefs are seen standing out of the water, forming perpendicular cliffs several hundred feet in height. Then also the interior of the island becomes once more dry land, and that, too, of great fertility.

Almost due south of that region, in the Pacific, where the coral islands abound, but at a great distance from them, and considerably within the limits of the Antarctic zone, lies South Victoria. Here, in lat. 76° S., Captain Ross discovered, in 1841, two volcanoes, which he called Erebus and Terror, after the names of his two ships. Of the former, which is the higher of the two, a view is given in the annexed woodcut. It is covered with perpetual snow from the bottom even to the tip of the summit. Nevertheless, it is continually sending forth vast columns of vapour, which glow with the reflection of the white hot lava beneath. These vapours ascend to a great height, more than two thousand feet above the top of the cone, which is itself twelve thousand feet above the level of the sea.

There is found in these frozen regions a remarkable botanical curiosity, having a certain connexion with volcanoes. The waters of the ocean, all along the borders of the icy barrier, produce in amazing abundance the family of water-plants named Diatomaceæ. The Diatoms are so called from their faculty of multiplying themselves indefinitely by splitting into two; and so rapidly is this process performed, that in a month a single diatom may produce a thousand millions. The quantity found in the Ant-

arctic regions is so immense that, between the parallels of 60° and 80° of south latitude, they stain the whole surface of the sea of a pale olive-brown tint. These plants, which are so minute as to be individually invisible, save under the higher powers of the microscope, have the curious property of encrusting themselves with a sheath, or shell, of pure silica. These shells remain after the death of the plant, and are as indestructible as flint. They are marvellous objects, both as respects the elegance of their forms and the beauty of their markings. So great is the accumulation of these shells at the bottom of the sea, that they have formed an immense bank 400 miles in length by 120 in breadth, between the 76th and 78th degrees of south latitude. One portion of this bank rests on the coast at the foot of Mount Erebus.

Now, it is remarkable that these microscopic shells of Diatoms are not unfrequently found in the ejections of volcanoes; while it is generally supposed that, in the case of those situated near the sea, eruptions are caused by the formation of explosive steam consequent on the access of sea-water to the reservoirs of molten lava lying underground. The proximity of this Diatomaceous bed to Mount Erebus would easily explain how these minute shells might be found abundant in the fine dust ejected from that volcano.

CHAPTER X.

Volcanoes of Java—Papandayang—Mountain Ingulfed—Great Destruction of Life and Property—Galoen-gong—Destructive Eruption—Mount Merapia—Great Eruption, with Hurricane—Another, very destructive—Mud Volcano—Crater of Tankuban-Prahu—Island of Sumbáwa—Volcano of Tomboro—Terrific Eruption—Timor—A Volcano quenches itself—Cleaving of Mount Machian—Sangir—Destructive Eruption—Bourbon.

ONE of the most marvellous volcanic regions in the world is that composed of the islands of the Malayan Archipelago in the Indian Ocean. They form a chain stretching from east to west, but curving up towards the north at the western extremity. The most easterly of the chain is Timor, the most westerly Sumatra.

The most interesting of the group is Java, which is almost entirely of volcanic origin, and contains no less than thirty-eight mountains of that conical form which indicates their having at one time or other been active volcanoes. Only a few of them, however, have been in activity in more recent times. The most remarkable eruption was that of the mountain named Papandayang, which occurred in 1772. During this convulsion the greater part of the mountain, which was formerly one of the largest in the island, was completely swallowed up in some great underground gulf.

On the night between the 11th and 12th of August of that year, the mountain appeared to be wholly enveloped in a remarkable luminous cloud. The inhabitants fled in consternation; but before they could all escape, the mountain began to totter, and the greater part of it tumbled down and disappeared. The crash with which it fell was dreadful, the noise resembling the discharge of volleys of artillery. Besides that part of the mountain which thus fell in, a large extent of ground in its neighbourhood was ingulfed. The space measured fifteen miles in length and six in breadth. The ground for many miles round this space was covered with immense quantities of ashes, stones, cinders, and other substances thrown out by the volcano. These were, on many parts of the surface, accumulated to the height of three feet; and even at the end of six weeks, the layers thus deposited retained so much heat as to render the mountain inaccessible. By this dreadful occurrence forty villages were destroyed, some ingulfed with the ground on which they stood, others buried under the loose materials which had been ejected. Not far short of three thousand of the inhabitants perished.

Another of the volcanoes of Java, called Galoengong, burst into eruption in 1822, commencing with a terrible explosion of stones, ashes, &c., followed by a stream of hot mud, which overspread a large tract of ground. This eruption proved still more fatal to human life, about four thousand persons having been destroyed.

So lately as September 1849, Mount Merapia

another volcano in this island, which had been supposed to be quite extinct, burst forth into an eruption, which lasted three days. It was accompanied by a violent hurricane. The bed of a river was filled up by the matter thrown out from the crater, and the destruction of property in crops, &c., was immense. Fortunately the inhabitants succeeded in making their escape, so that no lives were lost. A second eruption of this mountain however, in January 1864, was more disastrous, three hundred and fifty people having perished.

Java likewise contains a remarkable mud volcano. When viewed from a distance, there are seen to rise from it large volumes of vapour, like the spray from the billows dashing against a rocky shore, and there is heard a loud noise like distant thunder. On a nearer approach, the source of these phenomena is seen to be a hemispherical mound of black earth mixed with water, about sixteen feet in diameter, and which at intervals of a few seconds is pushed upwards by a force acting from beneath to a height of between twenty and thirty feet. It then suddenly explodes with a loud noise, scattering in every direction a quantity of black mud, which has a strong pungent smell resembling that of coal-tar, and is considerably warmer than the air. With the mud thus thrown out there has been formed around the mound a large perfectly level and nearly circular plain, about half a mile in circumference. The water mixed with the mud is salt, and the salt is separated from it by evaporation for economical purposes. During the rainy season the action of this mud vol-

cano becomes more violent, the explosions are louder, and the mud is thrown to a greater height.

The crater of Tangkuban-Prahu, another of the volcanoes of Java, presents a remarkable appearance. On approaching its edge, nothing is seen but an abyss, from which dense clouds of vapour continually arise, with hideous sounds, like the steam rushing from the open valves of hundreds of steam-engines. This great abyss consists really of two craters, separated the one from the other by a narrow ridge of rock, to which it is possible to descend and view them both. Each of them is elliptical in form, and surrounded by a crater-wall. That of the western, which the natives call the poison-crater, is a rapid slope nearly a thousand feet in depth, and is densely covered with brushwood almost to the bottom. The flat floor of this deep basin is continually sending out vapours, and in its centre is a pool of boiling water of a sulphur yellow colour. The floor itself is nothing but a crust of sulphur full of rents and holes, whence vapours constantly arise. This crust covers a surface of boiling hot bitter water, and by breaking it beautiful crystals of sulphur may be obtained.

The eastern is called by the natives the king's-crater; its walls are only between five and six hundred feet in depth, and are perfectly bare from top to bottom. The surfaces of the rocks composing them are grayish white, an effect produced upon them by the action of the vapours, to which they are continually exposed. The bottom of this crater consists of mud mixed with sulphur; but round the

edges are some stones and hard masses. These are the remnants of an eruption which took place from this crater in 1846, when there was thrown up a great mass of sulphurous boiling mud, accompanied by quantities of sand and stones. This mountain, therefore, seems to be also more of the nature of a mud volcano, than of one which throws out burning lava.

Nearly in a right line to the eastward of Java lies the Island of Sumbáwa, in which stands the volcano of Tomboro, the most violent in its eruptions of any in the world. One of the most remarkable occurred in the year 1815, beginning on the 5th of April and continuing till the middle of July. Its effects were felt over an immense tract of country, embracing the Molucca Islands, Java, and portions of Celebes, Sumatra, and Borneo. The concussions produced by its explosions were sensible at a distance of a thousand miles all round; and their sound is said to have been heard even at so great a distance as seventeen hundred miles. In Java the day was darkened by clouds of ashes, thrown from the mountain to that great distance (three hundred miles), and the houses, streets, and fields, were covered to the depth of several inches with the ashes that fell from the air. So great was the quantity of ashes ejected, that the roofs of houses forty miles distant from the volcano were broken in by their weight. The effects of the eruption extended even to the western coasts of Sumatra, where masses of pumice were seen floating on the surface of the sea, several feet in thickness and many miles in extent.

From the crater itself there were seen to ascend three fiery columns, which, after soaring to a great height, appeared to unite in a confused manner at their tops. Ere long, the whole of the side of the mountain next the village of Sang'ir seemed like one vast body of liquid fire. The glare was terrific, until towards evening, when it became partly obscured by the vast quantities of dust, ashes, stones, and cinders thrown up from the crater. Between nine and ten o'clock at night the ashes and stones began to fall upon the village of Sang'ir, and all round the neighbourhood of the mountain. Then arose a dreadful whirlwind, which blew down nearly every house in the village, tossing the roofs and lighter parts high into the air. In the neighbouring sea-port the effects were even more violent, the largest trees having been torn up by the roots and whirled aloft. Before such a furious tempest no living thing could stand. Men, horses, and cattle were whirled into the air like so much chaff, and then dashed violently down on the ground. The sea rose nearly twelve feet above the highest tide-mark, sweeping away houses, trees, everything within its reach.

This whirlwind lasted about an hour, and then commenced the awful internal thunderings of the mountain. These continued with scarcely any intermission until the 11th of July, when they became more moderate, the intervals between them gradually increasing till the 15th of July, when they ceased. Almost all the villages for a long distance round the mountain were destroyed; and it is computed that

nearly twelve thousand persons perished. By far the greatest part of this destruction was wrought by the violence of the whirlwind which accompanied the eruption.

Considerably to the eastward of Sumbáwa lies the Island of Timor, in which there was for a long time a volcanic peak, whose perpetual fires served as a light-house to mariners navigating those seas. But in the year 1637 there took place a great eruption of the mountain, which ended in its being gobbled up whole and entire, leaving nothing behind it but a lake, in which its fires were quenched, and which now occupies its place.

To the north of Timor lie the Molucca Islands, several of which are volcanic. In one of them, named Machian, there occurred in the year 1646 an extraordinary event. A mountain was rent from top to bottom, sending out great columns of fire and dense vapours. The two parts now remain two distinct mountains.

In the Island of Sangir, another of the Moluccas, there was a violent eruption in March 1856. A large portion of the mountain fell down, and tremendous floods of water issued forth. The destruction that ensued was dreadful, upwards of two thousand persons having perished.

In another part of the Indian Ocean, near Madagascar, lies the little Isle of Bourbon, containing the volcano Salazes, which occasionally throws out the curious thready substance already mentioned, so strongly resembling spun glass.

CHAPTER XI.

Mud and Air Volcanoes—Luss—Macaluba—Taman—Korabetoff—New Island in the Sea of Azof—Jokmali—Fires of Baku—Mud Volcano in Flank of Etna—Air Volcanoes of Turbaco, Cartagena, and Galera-Zamba.

THE curious mud volcano in the Island of Java, described in the preceding chapter, although presenting some peculiar features, is not the only one of the kind in the world. Mud, as you have learned, is often thrown out in great quantities, along with boiling water, even by true volcanoes, which at other times eject ashes and lava. But there are some volcanoes that never throw out anything else than mud and water, gas and steam. Such are called mud volcanoes or salses.

The most remarkable assemblage of mud volcanoes in the world exists in the district of Luss, lying at the south-east corner of Beloochistan. They extend over a very large area, and are exceedingly numerous. The cone of one of them is no less than four hundred feet high, and the crater at the top is ninety feet in diameter. The mud in the crater is quite liquid, and is constantly disturbed by bubbles of gas, and occasionally by jets of the mud itself.

More familiarly known is the mud volcano of Macaluba, near Girgenti, in Sicily. It is situated in a country much impregnated with sulphur and other

inflammable matters. The top of the hill is covered with dry clay, in which are numerous basins full of warmish water mixed with mud and bitumen. From these small craters bubbles of gas arise from time to time; but at long intervals they become much more active, and throw up jets of wet mud to the height of nearly two hundred feet. This mud smells strongly of sulphur.

In the peninsula of Taman, near the entrance to the Sea of Azof, there is a group of mud volcanoes, from one of which there was a considerable eruption on the 27th of February 1793. It was preceded by underground detonations, and accompanied by a column of fire and dense vapour, which rose to the height of several hundred feet. The discharge of mud and gas was abundant. The accompaniment of fire and smoke makes this eruption more nearly resemble that of a true volcano.

There is in the adjacent parts of the Crimea a mountain named Korabetoff, which also presents similar phenomena. On the 6th of August 1853, a column of fire and smoke was seen to rise from the top of this mountain to a great height, and it continued for five or six minutes. Two other similar but less violent ejections of fire and smoke followed at short intervals. These appearances were the accompaniments of an eruption of black fetid mud, which overspread the ground at the foot of the mountain to a considerable depth.

A still more striking phenomenon occurred in the Sea of Azof, on the 10th of May 1814. On that day a column of flame and very thick smoke arose

AIR VOLCANOES OF TURBACO.

out of the water, with a loud report like that of a cannon, and masses of earth with large stones were tossed high up into the air. Ten eruptions of this kind succeeded each other at intervals of about a quarter of an hour; and after they had ceased for a time, they began again during the night. Next morning it was found that an island had risen out of the sea, between nine and ten feet in height, surrounded by a lower level of hardened mud. A strong fetid smell, probably that of petroleum, proceeded from the island, and extended for a considerable distance all round.

Another mud volcano, named Jokmali, near the Caspian Sea, was formed in November 1827. In this case, also, the ejection of mud was for several hours preceded by flames, rising to so great a height that they could be seen at a distance of twenty-four miles. Large pieces of rock were at the same time thrown up and scattered to considerable distances all round. The entire district in which this mountain is situated, has its soil copiously impregnated with petroleum, and numerous wells are formed for its collection. Quantities of this mineral oil are frequently found floating on the sea, along the neighbouring shores, where the sailors are in the habit of setting fire to this floating petroleum, while they dexterously steer their boats so as to avoid the flames. In this district also stands the city of Baku, held sacred by the Parsees, or fire-worshippers, who have here built a temple, in which are kept burning perpetual fires, fed by the naphtha springing from the ground.

During the past year, 1866, a small mud volcano has been formed in the flanks of Mount Etna. It began with an outburst of strong jets of boiling water. First, one rose to the height of about six feet, then several others broke out, whereupon the height of the whole set diminished. There was much gas bubbling through the water, and some petroleum floated on its surface. It was very muddy, and left a thick deposit as it flowed away. Neither flames nor noise accompanied this eruption.

There are also diminutive volcanoes, consisting of small conical hills, from which nothing seems to be emitted but various sorts of gas. These are called air volcanoes. Such are those of Turbaco in South America, discovered by Baron Humboldt, who has left us a picture of them, of which you here have a copy. These volcanic hillocks are truncated cones, eighteen or twenty in number, composed of hardened mud, from 18 to 24 feet in height, and from about 140 to about 180 feet in diameter at the base. The small craters at the top are filled with liquid mud, whence bubbles of gas, chiefly nitrogen, are being continually disengaged.

There is a similar, but much larger, group in the neighbouring province of Cartagena. It consists of about one hundred cones spread over a district of nearly four hundred square leagues. There is also a group of about fifty cones within a range of four or five miles in the adjacent peninsula of Galera-Zamba. A sub-marine volcano, from which there have been several eruptions, is supposed to be connected with these numerous salses.

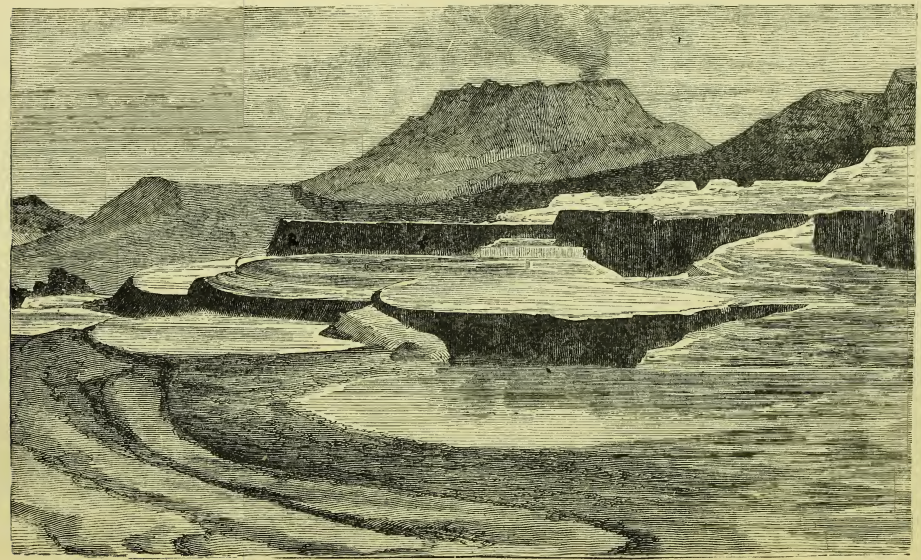
CHAPTER XII.

New Zealand—Boiling Fountains and Lakes.

IN the eruptions of mud volcanoes, described in the foregoing chapter, a frequent ingredient is boiling water. There are, however, several instances in which there are thrown up jets of boiling water that are not intermingled with mud, but in which the water is either pure or impregnated with some mineral which it holds in perfect solution. Of this nature are the Geysers of Iceland and California, already described.

In New Zealand there is another variety of this phenomenon, the boiling water issuing forth, not in intermittent jets, as in the Geysers, but in perpetually flowing springs, forming lakes, in which the water remains nearly at the boiling point. These springs and lakes occur at a place called Roto-Mahana. The annexed woodcut will convey an idea of their appearance.

There are several basins raised one above another, and all higher than the level of the large lake. The highest is of an oval form, and about two hundred and fifty feet in circumference. It is filled from an opening at the height of about a hundred feet above the level of the lower lake. At various stages below



BOILING LAKES OF ROTO-MAHANA

this upper basin are numerous other springs, from which several similar basins are filled. The whole of these basins empty themselves into the large lake below, and the water in all of them is nearly boiling hot, giving forth, with a hissing sound, volumes of white vapour.

These waters are richly impregnated with carbonate of lime, which has formed all round the margins of the basins beautiful incrustations of snowy whiteness. The sand round the lake is very warm; and if a stick be thrust into it, jets of steam arise.

Doubtless, some years hence, the enterprising English settlers will establish hot baths here. Not far from the lake there are smaller basins, in which the water is not beyond what would be agreeable for a warm bath; while it is of a blue colour and beautifully clear.

On both banks of the river Waikato, also in this neighbourhood, are found numerous basins full of boiling mud or slime, which cannot be approached save with extreme care, owing to the softness and slipperiness of the soil. The largest of these basins is oval in form, 14 feet long by 8 feet wide, and about as much in depth. It contains hot mud of a bright red colour, being strongly impregnated with oxide of iron. Large viscous bubbles are continually rising to the top, and on bursting they emit a fetid, sulphureous smell. These phenomena are nearly akin to those of a mud volcano.

CHAPTER XIII.

Underground Sounds—Quito—Rio Apure—Guanaxuato—Melida—Nakous.

NOT the least remarkable among the phenomena produced by volcanic forces, are the strange underground noises which are occasionally heard. For the most part these are the preludes either of shocks of earthquake or of volcanic eruptions. Those which for months preceded the upheaval of the volcano of Jorullo, will recur to your remembrance. For about a month before the great mud eruption from Tunguragua on 4th February 1797, already described, there proceeded from the interior of that mountain noises of the most fearful kind. These would occur suddenly in the midst of perfect silence. They were heard by Antonio Pineda, the naturalist, who was there at the time, and they led him to foretell the approach of some great convulsion. Strange to say, however, the catastrophe itself was unaccompanied by underground noises any where near the volcano. But, stranger still, at Quito, which is distant about 200 miles, a short time after the eruption began, there were heard tremendous underground thunders. But this distance, between the site of the underground noises and the probable focus of disturbance, was far exceeded in another

remarkable instance. It is stated by Humboldt that, in the grassy plains of Calaboso, on the banks of the Rio Apure, a tributary of the Orinoco, there were heard, over a large extent of country, loud underground thunders, unaccompanied by any shaking of the ground; while great streams of lava were being poured forth from the crater of Morne-Garou, in the Island of St. Vincent, at the distance of no less than 632 miles in a right line. This was as though an eruption of Mount Vesuvius were accompanied by underground thunders in Normandy.

There have, nevertheless, been instances of the existence of such underground noises, without their having been followed either by an earthquake, by a volcanic eruption, or any other outward appearance whatever. One of the most remarkable cases of the kind, was that mentioned by Humboldt as having occurred at Guanaxuato in Mexico, a mountain-city situated far from any active volcano. This celebrated traveller states that these noises began on the 9th of January 1784, and lasted above a month. The sounds were at first neither very loud nor very frequent; but from the 15th to the 16th of January they resembled continuous low rolling thunder, alternating with short loud thunder-claps. The sounds then gradually died away and nothing came of them, although they excited great terror among the inhabitants while they lasted. There are mines in the neighbourhood fifteen hundred and ninety-eight English feet in depth, yet neither in them nor at the surface could the least tremor be detected.

A somewhat similar phenomenon occurred in the

Island of Melida in the Adriatic, off the coast of Dalmatia, where underground rumblings were heard from March 1822 to September 1824; but in this case the sounds were sometimes accompanied by shocks.

A still more singular phenomenon of this sort occurs on the borders of the Red Sea, at a place called Nakous, where intermittent underground sounds have been heard for an unknown number of centuries. It is situated at about half a mile's distance from the shore, whence a long reach of sand ascends rapidly to a height of about three hundred feet. This reach is about eighty feet wide, and resembles an amphitheatre, being walled in by low rocks. The sounds coming up from the ground at this place recur at intervals of about an hour. They at first resemble a low murmur; but ere long there is heard a loud knocking, somewhat like the strokes of a bell, and which, at the end of about five minutes, becomes so strong as to agitate the sand.

The explanation of this curious phenomenon given by the Arabs, is, that there is a convent under the ground here, and that these sounds are those of the bell, which the monks ring for prayers. So they call it "Nakous," which means a bell. The Arabs affirm that the noise so frightens their camels when they hear it as to render them furious. Philosophers attribute the sounds to suppressed volcanic action—probably to the bubbling of gas or vapours underground.

CHAPTER XIV.

Extinct Volcanoes — Auvergne — Vienne — Agde — Eyfel — Italy— Lacus Cimini—Grotto del Cane—Guevo Upas—Talaga Bodas—The Dead Sea.

THERE are two sorts of extinct volcanoes: *first*, those in which all evidences of activity have entirely ceased; and, *secondly*, those in which a subdued state of activity lingers. The former are more widely distributed than the latter; but sometimes both kinds occur in the same district of country.

Extinct volcanoes are found in the district of Auvergne in France. Solidified streams of lava occur at Volvic near Riom; and the crater whence they descended is still visible on the top of the Puy de Nugere. It is an oblong basin, having its edge broken on the side down which the lava flowed. In its descent the fiery stream appears to have encountered a knoll of granite, by which it was divided into two branches. These seem to have reunited lower down, and thence to have overspread the valley beneath.

The Puy de Côme, a mountain near Clermont, appears to have sent forth two streams of lava, which have effected considerable changes in the surface of the country—blocking up the courses of rivers,

diverting them into new channels, and forming swamps in the old. On the top of Puy Pariou, to the north of Clermont, there exists a perfect crater, quite round, and about two hundred and fifty feet deep, whence there has flowed a stream of lava, whose course can be distinctly traced. The summit of Puy Graveniere, a long round-backed hill also near Clermont, consists almost entirely of a heap of volcanic cinders, which have obliterated all traces of a crater; but two streams of lava appear to have flowed from the sides of the mountain. The Puy de Dôme, and the mountains in its neighbourhood, likewise appear to be of volcanic origin, and to have been upheaved somewhat in the same manner as Jorullo. Although the aspect of the mountains of Auvergne indicates so clearly their having been active since the surrounding country acquired its present general conformation, neither history nor tradition has preserved any record of their eruptions.

There is extant, however, a letter from Sidonius Apollinaris, a cotemporary of Pliny, addressed to the Bishop of Vienne, in which he refers to forms of prayer which had been appointed by the bishop at the time when earthquakes demolished the walls of Vienne, and the mountains, opening, vomited forth torrents of inflamed materials. It hence appears that the extinct volcanoes in the neighbourhood of Vienne, and perhaps those of Le Puy, had been in a state of eruption not long after the beginning of the Christian era. To the westward of the latter town, there is a number of small volcanic craters, of which the two largest are the Lake de Bouchet and the Crater of

Bar, which also appears to have been at one time a lake, but is now dry. The former has its greatest diameter about 2300 feet, with a depth of about 90 feet. The latter is on the top of a mountain, which is composed entirely of such substances as are ejected by volcanoes. Its diameter is about 1660, and its depth about 130 feet; while it is almost perfect in its form. The mountains near Vienne exhibit streams of lava, which accommodate themselves to the existing valleys. Near Agde also, on the shores of the Gulf of Lions, on the top of a hill named St. Loup, there is an extinct crater, whence have descended two streams of lava apparently of recent origin. On one of them the town of Agde has been built; the other projects into the sea.

The district of Eyfel, on the borders of the Rhine, is another in which extinct volcanoes abound. They occur mostly in the form of circular craters, which are now filled with water, their borders consisting of volcanic ejections. They also exhibit various superficial streams of lava. One of the most remarkable of these round craters lies near Andernuch, a little west of the Rhine. It is named the Lake of Laach, and is nearly two miles in circumference. On its margin are found numerous volcanic ejections, exactly resembling those of Mount Vesuvius. Notwithstanding these evidences that the extinct volcanoes of Eyfel have been in activity since the country acquired its present conformation, there are no historical records of their operations. There is, indeed, a passage in Tacitus referring to fires that issued from the earth near Cologne; but his description does not warrant the

conclusion that the event to which he alludes was of the nature of a volcanic eruption. The Drachenfels on the eastern bank of the Rhine, and the other mountains in its neighbourhood, belong to the more ancient volcanic formations. The same may be affirmed of the other mountains scattered throughout Germany and central Europe generally, in which rocks of volcanic origin occur.

There are a good many traces of extinct volcanoes in Italy, besides those of the Phlegræan fields already mentioned. In general character they resemble those previously described. The chief localities are certain lakes, near Volterra in Tuscany, which give forth very hot sulphurous and boracic acid vapours; a small sulphureous lake near Viterbo continually giving forth bubbles of gas; the Lake of Vico between Viterbo and Rome; the mountain and Lake of Albano near Rome; Mount Vultur in the Apennines, in the province of the Basilicata; and Lake Agnano near Naples. Of these, the Lakes of Vico and Agnano are the most interesting. The former is the ancient Lacus Cimini, and old authors state that its site was once occupied by a town, whose ruins used to be visible at the bottom of the lake when the water was clear. The ground, with the town upon it, is said to have been ingulfed during a volcanic convulsion, when the lake was formed in its place.

The Lake Agnano is the site of an ancient volcanic crater, and on its margin is situated the Grotto del Cane, so famous for the deadly vapours it exhales. These consist of carbonic acid gas, in combination with watery vapour. This celebrated Grotto is thus

described, in his work on volcanoes, by Dr. Daubeny, who visited the spot :—

"The mouth of the cavern being somewhat more elevated than its interior, a stratum of carbonic acid goes on constantly accumulating at the bottom, but upon rising above the level of its mouth, flows like so much water over the brim. Hence the upper part of the cavern is free from any noxious vapour; but the air of that below is so fully impregnated, that it proves speedily fatal to any animal that is immersed in it, as is shown to all strangers by the experiment with the dog.

"The sensation I experienced, on stooping my head for a moment to the bottom, resembled that of which we are sometimes sensible on drinking a large glass of soda water in a state of brisk effervescence. The cause in both instances is plainly the same.

"The quantity of carbonic acid present in the cavern at various heights, was shown by immersing in it various combustibles in a state of inflammation. I found that phosphorus would continue lighted at about two feet from the bottom, whilst a sulphur match went out a few inches above, and a wax taper at a still higher level.

"It was impossible to fire a pistol at the bottom of the cavern, for although gunpowder may be exploded even in carbonic acid by the application of a heat sufficient to decompose the nitre, and consequently to envelop the mass in an atmosphere of oxygen gas, yet the mere influence of a spark from steel produces too slight an augmentation of temperature for this purpose."

Similar phenomena, but on a grander scale, are presented by the extinct crater in the Island of Java called "Guevo Upas," the Poison-Valley. It is a level about half a mile in circumference, surrounded by precipitous rocks. From various parts of its soil carbonic acid gas is discharged in such quantities as to prove fatal to any animal venturing nigh. The ground is consequently strown with numerous skeletons. This valley gave rise to the famous figment about the upas-tree, which once obtained such general belief in Europe.

There is another extinct crater in Java, whence are exhaled vapours equally deadly, but which exert a most peculiar effect on the dead carcasses subjected to their influence. Instead of their being, as in the Guevo Upas, reduced to skeletons, the carcasses have all their bones dissolved by the vapours; while the flesh, skin, hair, and nails are by their action preserved from decay. This remarkable crater is situated near the volcano of Talaga Bodas.

Of all the extinct volcanoes in the world, however, none is so remarkable as the Dead Sea. That singular collection of salt and bitter water has the level of its surface depressed 1312 feet below that of the Mediterranean—thus indicating an enormous subsidence. The Dead Sea occupies the site of what was formerly the plain of Jordan, described as having been "well-watered everywhere, as the garden of the Lord, like the land of Egypt." One part of it, called the Vale of Siddim, was full of slime-pits—the only indications of volcanic action. When the cities of Sodom and Gomorrah, which stood in the

plain, were destroyed, the Lord, it is said, rained upon them fire and brimstone from heaven; but while these fell upon the cities from the atmosphere, it appears that they must have primarily been discharged from the earth; for "the smoke of the country went up as the smoke of a furnace." The phenomena, therefore, most likely resembled, in the first instance, those of Jorullo; but the catastrophe seems to have ended like the last great eruption of the volcano in Timor—the whole of the plain having been ingulfed and replaced by the salt lake, whose depressed level so clearly indicates the nature of its origin.

UNIVERSITY OF ILLINOIS-URBANA
3 0112 068964649